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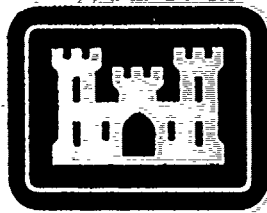
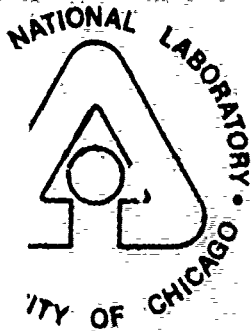
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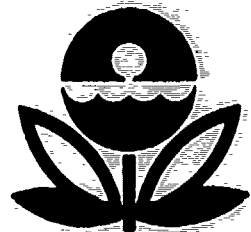
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Post Remedial Action in Former Lansdowne Radioactive
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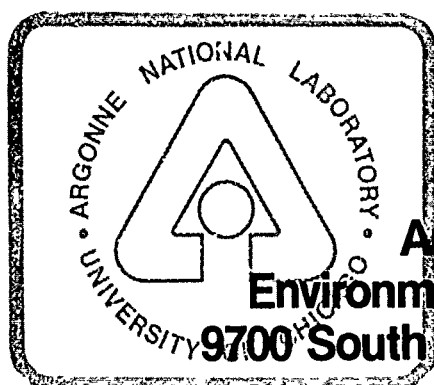
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VOLUME IV

RADIOLOGICAL OVERSIGHT AND CERTIFICATION

Post Remedial Action Report Lansdowne Radioactive
Residence Complex Dismantlement/Removal Project



Prepared By

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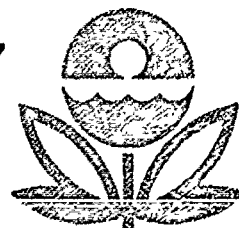
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13. ABSTRACT (Maximum 200 words) During the period 1924-1944, a University of Pennsylvania physics professor was engaged in the commercial production of radium sources for medical use in the basement of his home at 105 E. Stratford Ave., Lansdowne, Pa. As a result of the radium enrichment activities, the entire residence, the surrounding land, and the adjoining residence at 107 E. Stratford Ave. became contaminated. In August 1985, this site was officially added to USEPA's list of hazardous sites targeted for cleanup (Superfund). Argonne Natl. Laboratory was asked to provide onsite radiological overview to the U.S. Army Corps of Engineers for the remediation activities. The oversight included radiological surveying, laundry/waste water sampling, air sampling and logging of contamination in the soil. Additional oversight responsibility included verification that the soil remaining on the site, adjacent to the site and under the sewer line, as well as backfill soil were below the cleanup criterion of 5 pCi/g above the natural Ra-226 background level of 1.5 pCi/g. The exposure rate measurements from the restored site ranged from 8 to 11 micro-R/h, typical of background levels in this area. This report provides documentation that the cleanup criterion of 5 pCi/g of Ra-226 above background has been met. <u>Keywords:</u>					
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Water pollution; Radium/processing;

Alpha particle spectroscopy; Gamma ray spec-
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ARGONNE NATIONAL LABORATORY
9700 South Cass Avenue, Argonne, Illinois 60439

ANL/ESH/TS-90/101

RADIOLOGICAL OVERSIGHT AND CERTIFICATION REPORT
FOR THE LANSDOWNE PROPERTY
105-107 EAST STRATFORD AVENUE
LANSDOWNE, PENNSYLVANIA

August 1988 -- June 1989

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EXECUTIVE SUMMARY

During the period 1920-1944, a University of Pennsylvania physics professor was engaged in the commercial production of radium sources for medical use in the basement of his home at 105 E. Stratford Avenue in Lansdowne, Pennsylvania. The professor's residence comprised the western half of a three story duplex located in the approximate center of a 155 ft by 155 ft lot. As a result of the professor's radium enrichment activities conducted in a crude radiochemical laboratory in the basement of the 105 duplex, the entire residence became contaminated including the surrounding land. The adjoining residence at 107 E. Stratford Avenue also became contaminated, but to a much lesser extent.

The Pennsylvania Department of Health and the U.S. Public Health Service conducted an initial decontamination of the 105 duplex in 1964. Some contaminated articles were removed and transported to a radioactive waste disposal site outside Pennsylvania. Accessible surface contamination was stabilized with a heavy coat of paint.

The U.S. Environmental Protection Agency (USEPA) requested the Occupational Health and Safety Department of Argonne National Laboratory perform a radiological characterization of the site in 1984 in order to determine and document the levels of contamination present and also to estimate the effort required to release the site for unrestricted use (ANL 85).

In July of 1988, at the request of the U.S. Environmental Protection Agency and the U.S. Army Corps of Engineers (USACOE), Argonne National Laboratory was asked to provide onsite radiological overview for the dismantlement and remediation activities at the Stratford Avenue site. The scope of the overview support included radiological monitoring and surveying both within the duplex and in the environment during the dismantlement of the structure. One of the primary concerns was to avoid spreading any of the onsite contamination offsite. Laundry wastewater samples were collected and analyzed to ensure that the contaminant concentration was well within the regulations for discharge to the sanitary sewer system. Soil tubes were driven into the ground throughout the site and special radiation detectors were lowered down through the tubes to measure the level of contamination in the surrounding soil. This logging technique was used to determine the distribution of the radium contamination below the ground surface. Ultimately, the data collected from the logging procedure were used to estimate the approximate volume of soil onsite which was predicted to be above the clean-up criterion and thus required excavation and shipment offsite as contaminated waste. After all the soil excavation operations were completed, a final survey of the site was performed to ensure that the average ^{226}Ra concentration within each 10 ft by 10 ft gridded area was below the cleanup criterion of 5 pCi/g above the natural ^{226}Ra background level of 1.5 pCi/g. In some cases, additional remediation was necessary to remove isolated spots of contamination. The sewer line from the duplex to Stratford Avenue and to the junction with Union Avenue was found to be contaminated with radium to varying degrees. This entire length of sewer line was removed and replaced. The soil surrounding the sewer line was also contaminated, especially around pipe cracks and joints.

Based on the results of all the soil sample analyses, the entire site has been determined to meet the clean-up criterion. The backfill and topsoil which were used to restore the property to its original grade were sampled and analyzed to verify that neither was contaminated with radioactive material. Exposure rate measurements were made on the site after all backfilling operations were complete. The results of these measurements indicated that the radiation background at the restored site was consistent with the natural radiation background for this geographical location.

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NOMENCLATURE

Radionuclides:

- ^{40}K - potassium-40; found naturally in the environment
- $^{90}\text{Sr}/^{90}\text{Y}$ - strontium-90 and yttrium-90; instrumentation check source
- ^{214}Bi - bismuth-214; part of the radium-226 decay chain
- ^{214}Pb - lead-214; part of the radium-226 decay chain
- ^{222}Rn - radon-222; immediate decay product of radium-226
- ^{226}Ra - radium-226; part of the naturally-occurring uranium-238 series
- ^{227}Ac - actinium-227; part of the naturally-occurring uranium-235 series
- ^{228}Ra - radium-228; part of the naturally-occurring thorium-232 series
- ^{230}Th - thorium-230; parent of radium-226
- ^{231}Pa - protactinium-231; part of the naturally-occurring uranium-235 series
- ^{232}Th - thorium-232; parent of the naturally-occurring thorium series
- ^{234}U - uranium-234, part of the naturally-occurring uranium-238 series
- ^{235}U - uranium-235; parent of the naturally-occurring actinium series
- ^{238}U - uranium-238; parent of the naturally-occurring uranium series
- ^{239}Pu - plutonium-239; instrumentation check source
- ^{241}Am - americium-241; instrumentation check source

Radiological terms:

- WL - measure of radon daughter product exposure, working level
- $\mu\text{g/g}$ - results of uranium fluorometric analyses, micro-grams total uranium per gram of sample; also ppm
- pCi/g - activity concentration, e.g., pico-Curies of ^{226}Ra per gram of sample
- pCi/L - activity concentration, pico-Curies per liter

- $\mu\text{Ci/mL}$ - activity concentration, e.g., micro-Curies of ^{226}Ra per milli-liter of sample
- $\mu\text{R/h}$ - radiation exposure rate, micro-Roentgens per hour
- mrem - unit of radiation dose, mrem
- dis/min - unit of radioactivity, atom disintegrations per minute
- cts/min - instrument response to measuring radiation; counts per minute

Other terms:

- keV - used in context of specifying gamma-ray energies; kilo electron volts
- km - unit of distance, 1000 meters
- NaI - scintillation detector used to measure radiation; sodium iodide
- BGO - scintillation detector used to measure radiation; bismuth germanate
- m^3/h - air sample flow rate, cubic meters per hour
- μm - aerosol particle size, micro-meters

**RADIOLOGICAL OVERSIGHT AND CERTIFICATION REPORT
FOR THE LANSDOWNE PROPERTY
105-107 EAST STRATFORD AVENUE, LANSDOWNE, PENNSYLVANIA**

August 1988 - June 1989

by

C.M. Sholeen and W.J. Munyon

ABSTRACT

During the period 1920-1924, a University of Pennsylvania physics professor was engaged in the commercial production of radium sources for medical use in the basement of his home at 105 E. Stratford Avenue. As a result of the radium enrichment activities, the entire residence, the surrounding land, and the adjoining residence at 107 E. Stratford Avenue became contaminated.

In August 1985, this site was officially added to the U.S. Environmental Protection Agency's list of hazardous sites targeted for cleanup (Superfund). Argonne National Laboratory was asked to provide onsite radiological overview to the U.S. Army Corps of Engineers for the remediation activities. The oversight activities included radiological surveying, laundry waste water sampling, air sampling and logging of contamination in the soil. Additional oversight responsibility included verification that the soil remaining on the site adjacent to the site and under the sewer line, as well as backfill soil, were below the cleanup criterion of 5 pCi/g above the natural ^{226}Ra background level of 1.5 pCi/g. The exposure rate measurements from the restored site ranged from 8 to 11 $\mu\text{R/h}$, typical of the radiation background levels in this area.

This report provides documentation of the oversight activities and verification that the cleanup criterion of 5 pCi/g ^{226}Ra above background has been met.

1.0 INTRODUCTION

1.1 Historical Perspective

The five years between 1895 and 1900 were a remarkable period of scientific discovery. In 1895, Wilhelm Roentgen discovered x-rays while working with cathode ray tubes and Henri Becquerel the following year discovered radioactivity during his laboratory work with uranium ore and phosphorescent substances. Two years later, Marie Curie noticed that pitchblende ore produced greater air ionization than comparable samples of metallic uranium thus suggesting that there was some component in the ore, other than the uranium, responsible for such an effect. This led to her successful isolation of what she later named radium from a 100 gram sample of pitchblende ore. By 1902, factory-scale production of radium was underway in Paris. The first nuclear industry was rapidly developing early in the 20th century; however, the prized element was not uranium but radium. Tons of ore had to be mined and processed in order to extract a single gram of radium while the uranium content in the ore was virtually discarded as waste or sold as a low value by-product (La82). Commercial production of radium by extraction was first attempted in the United States by Stephen Lockwood in 1906 (La82) but his Rare Metals Reduction Company folded within two years because the radium extraction efficiency was poor and there was little demand for any of the ore by-products.

Dicran Hadjy Kabakjian and his family emigrated to the United States from his native Armenia in 1906 and settled in the Philadelphia area. By 1910, Kabakjian had earned a doctorate in physics from the University of Pennsylvania and began research at the Randall Morgan Physics Laboratory on the University campus seeking a solution to the problem of an apparent radium shortage. Also during this same time period, Joseph Flannery, a former Pittsburgh undertaker, organized the Standard Chemical Company in Canonsburg, PA to extract radium from carnotite ore mined in the western part of the United States. Carnotite is an ore containing potassium, vanadium, uranium, and radium. As more and more radium was extracted from carnotite and other ores, its availability became more widespread and claims to its miraculous curing capabilities multiplied. The market price for 1 gram of radium in 1910 was approximately \$120,000. During World War I, many hundreds of women were employed in the United States painting numerals on the instrument panels of various military aircraft with a luminous paint containing radium. Significant quantities of radium were ingested by these women when they would place the brush tip in their mouth in order to maintain a fine tip for the delicate painting of the instrument panels.

In 1913, Kabakjian sold a radium refinement process that he had developed while at the Randall Morgan Physics Laboratory to the W.L. Cummings Chemical Company of Lansdowne, PA. There are a variety of different methods that can be used to refine radium from mined ore. One such method involves converting a process precipitate of radium/barium sulfate to a solution of radium/barium chloride. The chloride solution is allowed to partially evaporate and, owing to the difference in solubilities between radium chloride and barium chloride, the radium salt precipitates out earlier and can be extracted from the solution in a richer concentration than that found in the original

solution. This process, called fractional crystallization, is repeated over and over until the final product obtained is nearly pure crystals of radium chloride (see Fig. 1). The radium chloride can then be used for a variety of applications including the assembly of radium needles for use in brachytherapy.

Luminous dial painting expanded to clock factories in 1920 and uses of radium for the treatment of real and/or imagined disorders increased to thousands of patients during the subsequent decade (St88). Important pitchblende deposits were discovered in the Haut Katanga district of the Belgian Congo in the early 1920s and the very high grade ore was shipped to a radium extraction facility in Oolen, Belgium. Between 300 and 400 tons of American carnotite ore was necessary to produce 1 gram of radium whereas less than 10 tons of Belgian Congo pitchblende was necessary to yield the same quantity of radium (La82). The radium extraction facility at Oolen forced an immediate shutdown of virtually all of the U.S. radium extraction facilities. The two largest facilities, one in Canonsburg, PA and the other in Colorado, became authorized sales agents and distributors for the Belgian company. Also during this time, the W.L. Cummings Company, of which Kabakjian served as a consultant, ceased operations. Two years later, in 1924, Kabakjian established a family-operated radium refinement operation in the basement of his duplex at 105 East Stratford Avenue in Lansdowne, PA, (see Figs. 2 and 3) a short distance from the defunct Cummings facility. Over the next two decades up until 1944, the Kabakjian family was actively engaged in the production of radium needles for distribution to medical facilities throughout the entire country. Their work also included the repair of damaged needles. As an indication of Kabakjian's output production, an estimated 5,000 radium sources, with an average source strength of 20 mg, were submitted to the National Bureau of Standards during a two year period for calibration (USDHEW 67).

According to a former employee's description of the radium refinement process, "a barium chloride/radium chloride mixture containing from 6-12 mg radium/lb was received from the refinery. This was further refined by fractional crystallization to about 50-100 mg/lb. The material was then converted to a bromide form and further refined to 90-98% radium bromide. The finished product was placed in glass tubes (Fig. 4 is a photograph of a glass tube 22-Z-625 found during soil excavation) containing 25-100 mg radium for storage until needed. [The quantity of radium] in the finished product was converted to the sulfate form and placed in platinum needles and cells made to the purchaser's specifications. Finished products were measured using an electroscope" (USDHEW67). The crude radiochemical laboratory established in the basement of the Kabakjian house resulted in a variety of different exposures to family members. The refinement operation necessarily involved exposure to airborne particulate matter such as dusts, radon and radon daughter products, chemicals such as hydrochloric or sulfuric acids, and the direct exposure to gamma-ray radiation. During the early years of Kabakjian's family-operated business, the saga of the radium dial painters was unfolding and in 1925, the U.S. Department of Labor declared brush-tipping an unsafe working practice. By 1934, Marie Curie had died of leukemia, a disease thought to be directly attributable to her years of work with radioactive materials. Unfortunately during this era there was a lack of sophisticated equipment to measure one's exposure to ionizing radiation and various chemical agents in the workplace. Workers, such as Kabakjian, often relied on physiological responses, changes in blood chemistry, to gauge whether

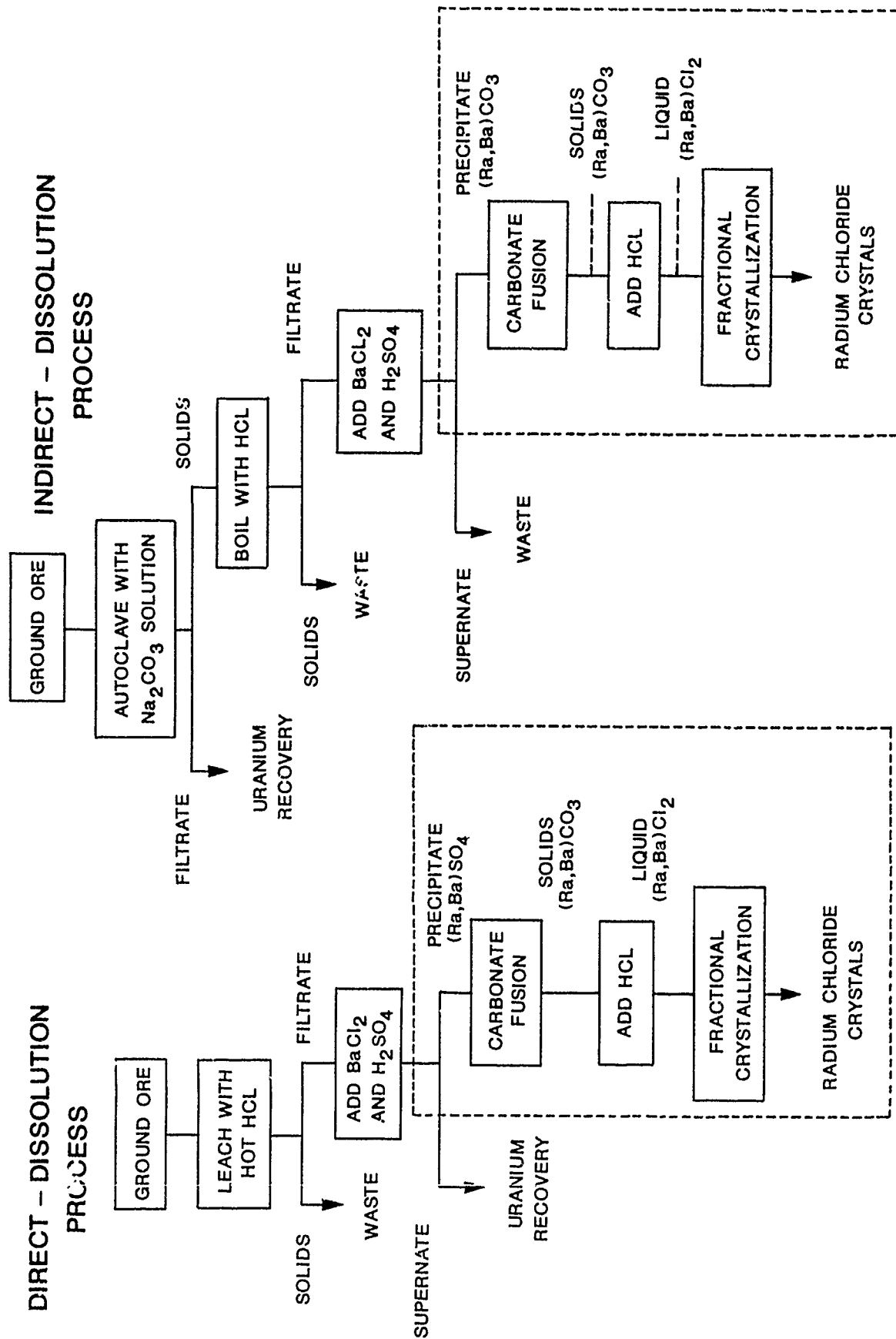


FIGURE 1 Methods of Radium Extraction from Ore (La 82). Note: Boxed regions refer to operations which may have occurred at 105 E. Stratford Avenue

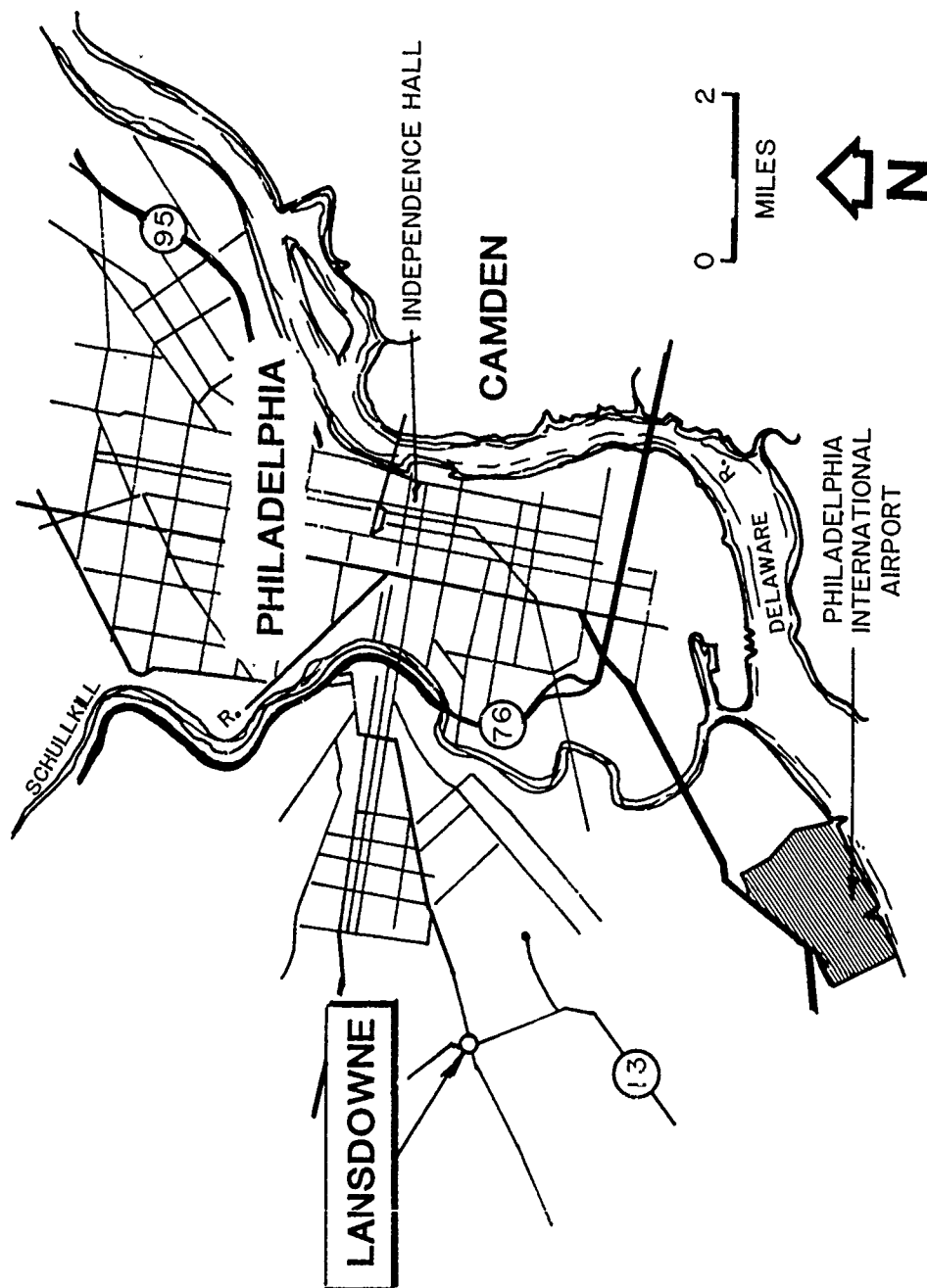


FIGURE 2 Map of Philadelphia Area Showing Lansdowne

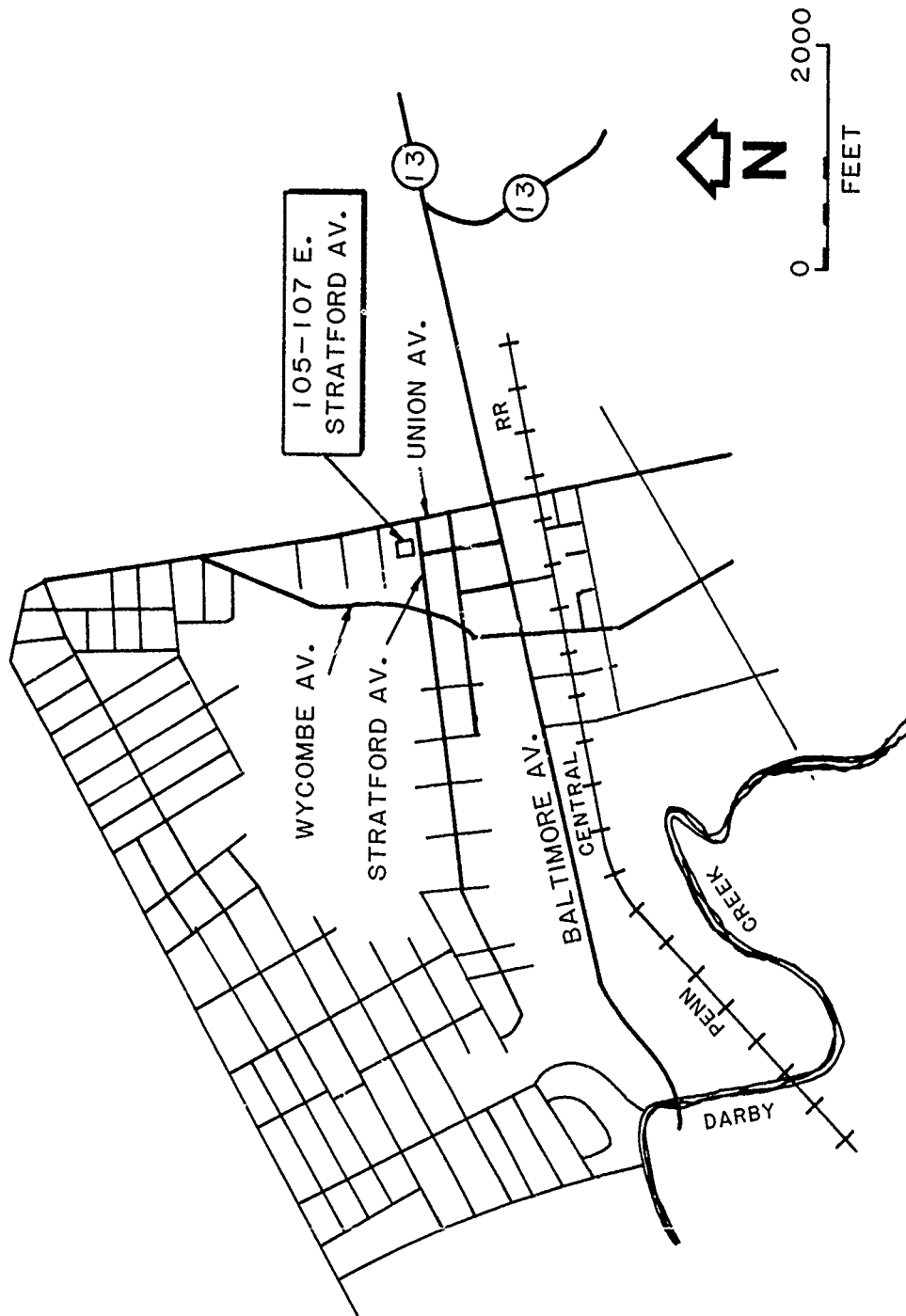


FIGURE 3 Map of Lansdowne Area Showing Location of Stratford Ave. Residence

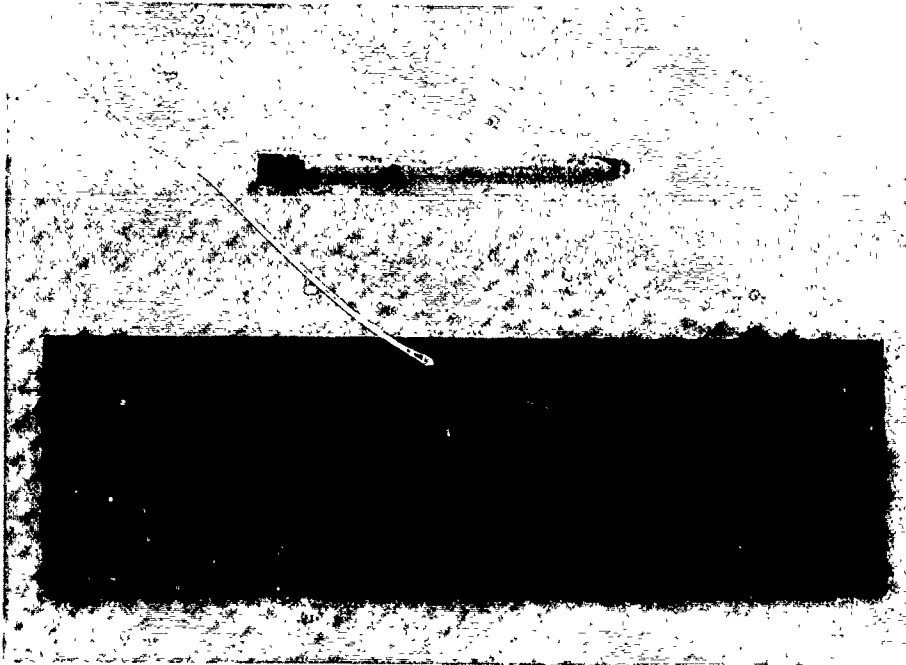


FIGURE 4 Glass Tube Excavated on Site Presumably Used to Store the Finished Product of Radium

they were receiving an excess exposure to radiation. By 1940, Kabakjian's health was beginning to deteriorate. Four years later he retired from his teaching post at the University of Pennsylvania and died the following year at the age of 70 from pulmonary fibrosis. A listing of the historical events, including those occurring at the Lansdowne site, are summarized in Appendix A.

1.2 Site Remediation Activities

During the 1950s, the Radiological Health Section of the Pennsylvania Department of Health began to inquire about locations throughout the state where radium was handled in the past. Interviews with various individuals in the radium processing business disclosed the possibility of radioactive contamination at a number of sites in Pennsylvania. One investigation led to the identification of the Kabakjian dwelling on Stratford Avenue. The professor's residence comprised the western half of a duplex structure located in the approximate center of a 155 ft by 155 ft lot (Fig. 5). Radiation measurements were made throughout the duplex and areas of high contamination were identified. Pennsylvania health authorities in consultation with the U.S. Public Health Service embarked on a decontamination effort which extended over a period of four months. In the fall of 1964, the house was declared safe and the occupants returned. After the Kabakjians sold the #105 half of the duplex in 1949, two different families lived in the duplex; the first until 1961 and the second from 1961 through the early 1985.

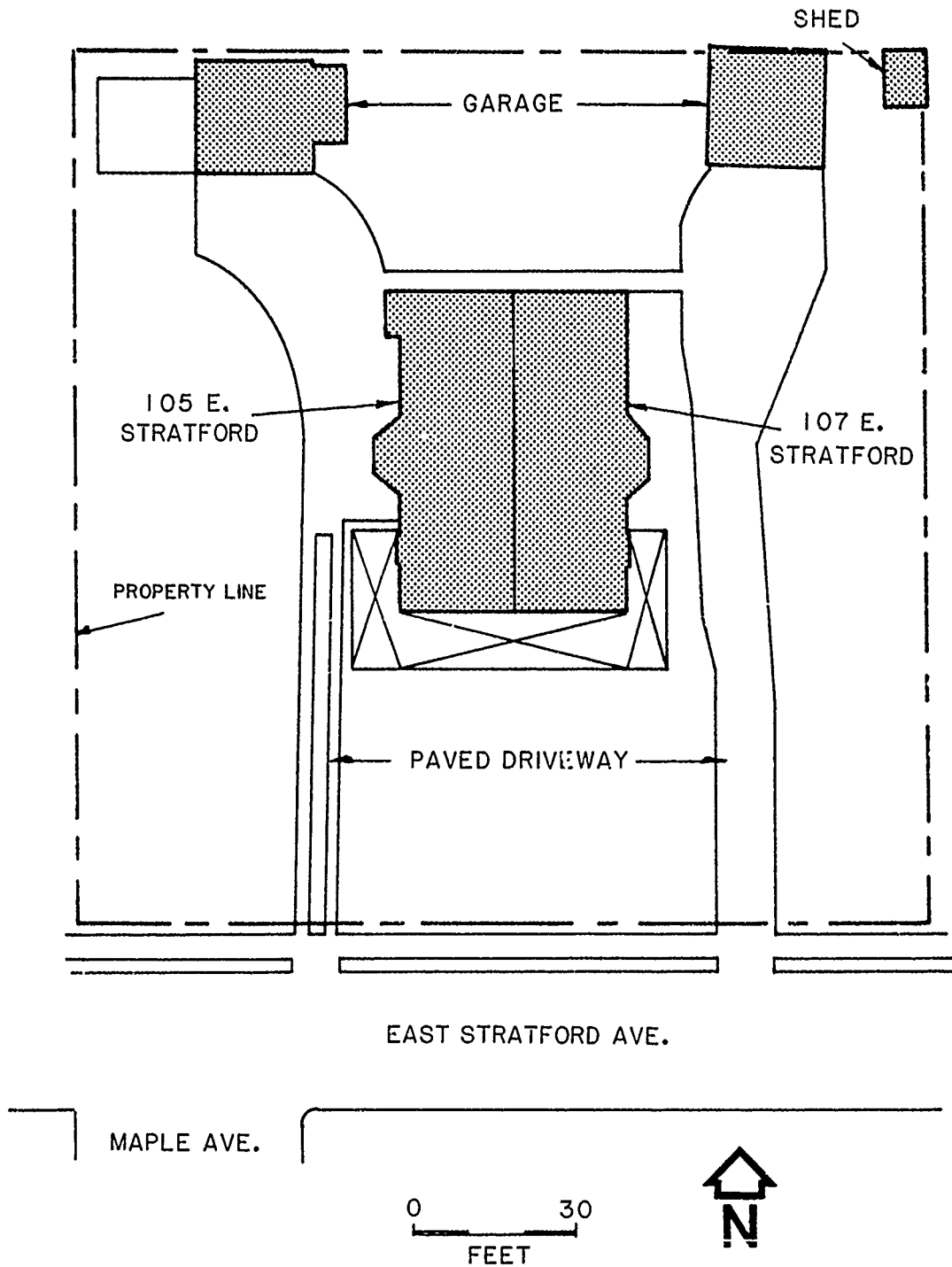


FIGURE 5 Site Map of Lansdowne Property

Regional surveys conducted in 1983 by the U.S. Environmental Protection Agency (USEPA) identified the Stratford Avenue house as a potentially radioactive site which might qualify for its toxic-waste cleanup program, often referred to as Superfund. Track-etch detectors were placed in the house during the summer of 1984 to estimate the ambient radon concentration. The results of these measurements were reported by the Pennsylvania Department of Environmental Resources to be well above a level which would normally necessitate remedial action. The Occupational Health and Safety Department of Argonne National Laboratory (ANL) was requested to perform a comprehensive radiological assessment of the Stratford Avenue property by the U.S. Department of Energy (ANL85). In August 1985, the Lansdowne site was officially added to the U.S. Environmental Protection Agency's list of hazardous sites targeted for cleanup.

In July 1988, at the request of the U.S. Environmental Protection Agency and the U.S. Army Corps of Engineers (USACOE), the Environment, Safety and Health Department (ESH), formerly the Occupational Health and Safety Department, of Argonne National Laboratory, was asked to provide onsite radiological overview of the dismantlement and remediation activities at the Stratford Avenue site. Chem-Nuclear Systems, Inc., was selected by USEPA as the private contractor to dismantle the duplex and remediate the site. The scope of the ANL radiological overview involved the following responsibilities: (1) provide technical assistance and advice to the USACOE onsite representative in areas involving radiation safety and radiological assessment; (2) provide a continuous review of the contractor's daily operations to ensure compliance with applicable statutory regulations; (3) review of the contractor's monitoring and surveying practices and assessment techniques to ensure that the expectations contained in the work contract were met; (4) perform independent radiological measurements on a variety of project activities (air and liquid effluent monitoring, contamination surveys, soil measurements) to certify the remediation activities of the Contractor; and (5) provide the USEPA and USACOE with a formal document certifying that the property at 105/107 Stratford Avenue and peripheral properties were completely remediated to meet the established cleanup criterion.

1.3 Report Objective

The purpose of this report is to certify to representatives of the USEPA and the USACOE that the property at 105/107 Stratford Avenue and the peripheral properties have been remediated to the extent specified by the cleanup criterion for ^{226}Ra in soil. The report also serves to document many of the oversight activities referred to above which were conducted by ANL personnel during various phases of the project.

2.0 OVERVIEW OF SITE REMEDIATION ACTIVITIES

2.1 Site Remediation Tasks

Specific remedial action operations included the following: (1) surface decontamination of select items of furniture for return to owner or disposal at an approved burial site, (2) dismantlement and surveying of the structure and disposal of contaminated material at an approved burial site; (3) surveying and excavation of contaminated soil, including that located on surrounding properties, and disposal at an approved burial site; (4) removal of contaminated sections of sewer line; and (5) removal and disposal of chemical waste.

2.2 Basis for Setting the Soil Cleanup Criterion

U.S. Department of Energy guidelines (FUSRAP87) for residual radioactive material at formerly utilized sites provide a limiting concentration for ^{226}Ra and ^{230}Th of 5 pCi/g averaged over the first 15 cm, and 15 pCi/g averaged over 15 cm thick layers of soil more than 15 cm below the surface. Based on the results of soil assays of the Lansdowne property (ANL85), ^{226}Ra was determined to be the primary gamma-emitting soil contaminant of concern. There was, however, additional concern that other alpha-emitting contaminants (namely ^{230}Th , ^{231}Pa , ^{227}Ac) were also present. There is no guidance pertaining to cleanup criteria for ^{231}Pa or ^{227}Ac . Prior to the remedial action effort, the clean-up criterion was set at 5 pCi/g above the natural background for the sum of these four radionuclides at all soil depths. Radiochemical analyses were performed on a selected number of soil samples during the early stages of remediation to determine whether concentrations of ^{230}Th , ^{231}Pa , and ^{227}Ac were present in excess of levels normally encountered in the natural environment. The results of the radiochemical analyses (Table 9) conducted by the Analytical Chemistry Laboratory at ANL indicated that the amount of ^{230}Th present in the samples analyzed was less than 5% that of the ^{226}Ra measured and only background levels of ^{227}Ac and ^{231}Pa were present. The cleanup criterion was modified to be based solely on the ^{226}Ra concentration; that is, the ^{226}Ra concentration was limited to no greater than 5 pCi/g above the natural ^{226}Ra concentration in soil. The natural ^{226}Ra concentration for this geographical location is taken to be 1.5 pCi/g. All subsurface depths below grade with measured ^{226}Ra concentrations in excess of 5 pCi/g above background required remediation.

2.3 Synopsis of Events

The project cleanup was divided into three different phases. Phase (1), August-November 1988, involved dismantlement of the duplex (Fig. 6). Phase (2), December 1988-March 1989, included the soil excavation activities. Phase (3), April-June 1989, included the soil verification activities and sewer line remediation. Due to the multi-task nature of the project, a significant amount of overlap occurred between these three phases.



FIGURE 6 Removing the Roof on the 107 Duplex

Phase I: Initially, most of the overview by ANL was directed toward making measurements within the duplex, particularly monitoring airborne activity levels and the degree of loose contamination which offered the potential for resuspension. Ensuring that the workers dismantling the structure were adequately protected from airborne radioactivity was a primary focus (Figs. 7, 8). Containment structures were built by the Contractor to control the potential spread of contamination into the environment (Fig. 9). External radiation exposure rates within the work zone from sources of contamination spread throughout the structure were quite low. During the early stages of dismantlement, attempts were made by the Contractor to segregate the rubble on the basis of radioactive contamination. However, this process proved to be extremely time-consuming and there was concern that some of the contamination would be missed during survey of the rubble. Eventually all of the rubble was treated as being contaminated with radioactive material for disposal purposes. Worker exposure to radioactivity via the inhalation pathway was of greatest concern. Additional effort was directed toward contamination control; that is, ensuring that workers exiting the radiation controlled area were free of clothing/skin contamination and that contaminated articles removed from the area were properly contained to prevent the spread of contamination. Worker clothing was laundered onsite and this required routine sampling of a laundry waste tank for alpha activity to ensure that the liquid effluent met the requirements for discharge to the sanitary sewer system. The limiting gross alpha concentration for discharge to the sanitary sewer system is $4\text{E-}7$ uCi/mL as specified in 10 CFR Part 20.

In early November, a section of the backyard (21 ft by 60 ft) was selected as a test area for ANL to demonstrate an alternate subsurface investigation technique to determine the distribution of radioactive contamination below ground.



FIGURE 7 Surveying Building Structures

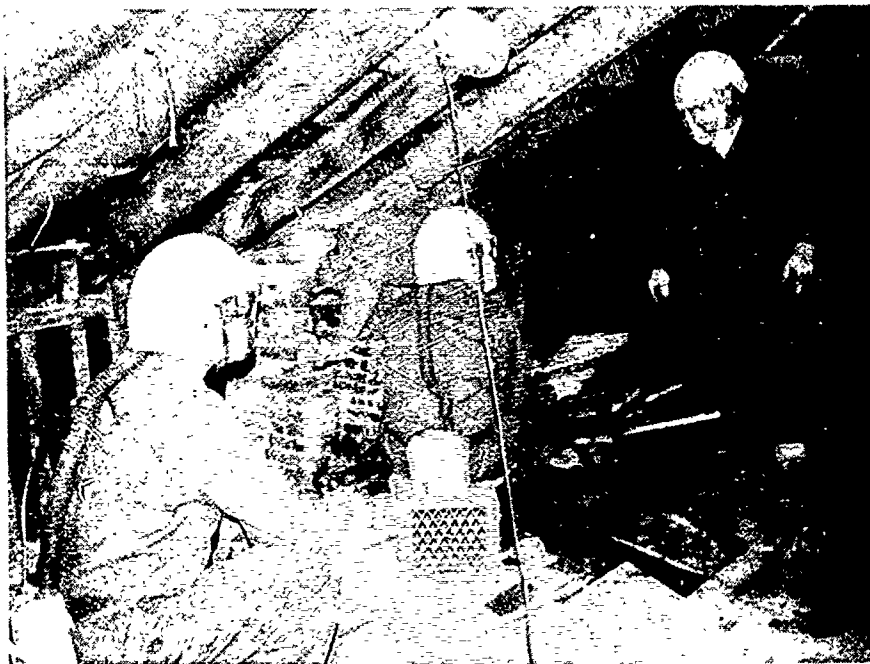


FIGURE 8 Respiratory Protection Worn During Dismantling Operations



FIGURE 9 Containment Structure Around the #105 Duplex Chimney

Phase II: By December 1988, the duplex had been dismantled to the first level flooring. Since the #105 residence basement contained some of the highest levels of contamination onsite, special attention was provided to ensure that workers were protected from the potential inhalation of airborne radioactivity. The volume of excavated soil was approaching the original estimate ($24,000 \text{ ft}^3$) of soil to be removed as contaminated waste. A request was made by the onsite U.S. Army Corps of Engineers representative to Argonne staff to make an estimate of the volume of contaminated soil remaining on the property, as well as the adjacent properties. To accomplish this task, it was necessary to make measurements to determine the depth distribution of the soil contamination onsite. An assessment of the contamination depth profile was obtained from a series of *in situ* measurements using a small ($3/8$ -inch diameter by $3/8$ -inch thick) sodium iodide detector, which was lowered down 1-inch diameter tubes driven into the ground to a depth of 10 feet. Measurements were made at $1/2$ -foot increments beginning at grade and extending downward. Over 450 tubes were driven into the ground throughout the site. The data provided a three dimensional profile of the soil contamination. Based on the previous work in the test area using this technique, a correspondence between the measured count rate and the cleanup criterion for ^{226}Ra in soil was established (see Table D5 samples from 60 Union St.). This enabled an estimate to be made of the approximate volume of contaminated soil which would need to be removed.

The months of January, February and March were directed at overseeing the removal of basement structures and excavating contaminated soil throughout the site. The primary objective during this period was to ensure that the cleanup criterion of

5 pCi/g ^{226}Ra (above the natural background) in soil was achieved. An additional objective was to ensure that time and resources were not spent removing volumes of soil below the established cleanup criterion. Also during this period an investigation was conducted in the Union Avenue sewer line to determine the extent of contamination. The garages located on two adjacent properties were torn down so that contaminated soil around their foundations could be excavated. One of the garages was demolished; the other garage was dismantled because it was found to be partially contaminated with radioactive material.

Phase III: A significant amount of effort during the months of April, May and June was devoted to verifying that all of the contaminated areas previously identified had been remediated by the contractor. During this phase of work, the sewer line on Stratford Avenue from the 105/107 property to Union Avenue was removed and replaced. Special attention was paid to surveying the material underneath the sewer line to identify areas of contamination from leakage due to cracked pipes and sewer line joints. After the soil on the site was verified to meet the criterion, excavated areas were backfilled with soil to restore the site to original grade.

3.0 RADIOLOGICAL INSTRUMENTATION

A variety of instruments were employed during the cleanup effort to assess levels of radioactive contamination. Portable gas-flow proportional counters were used to measure fixed and loose alpha and beta contamination within the house, on workers, and material removed from the house. A laboratory gas-flow proportional counter was used to measure the alpha and beta activity collected on workplace air samples, the alpha activity content of laundry waste tank samples, and the alpha/beta activity on smears taken from various workplace surfaces. A radon gas monitor was used to measure the ^{222}Rn concentration in the house, mainly in the #105 living room. Gamma survey meters were used for surveying ground surfaces, especially during soil remediation activities. Subsurface measurements were made using scintillation detectors designed and assembled at Argonne National Laboratory. A hyper-pure germanium detector spectrometry system was used for quantifying the activity concentration of ^{226}Ra in soil samples. A pressurized ion chamber was used to measure the ambient gamma-ray exposure rate on the site after all remediation activities had been completed. The following is a detailed description of the instrumentation used during the course of the work. Photographs of the instruments used during the project are provided in Appendix B.

- PAC-4G-3 -- The Eberline® PAC-4G-3 is one of the primary instruments used for surveying contaminated surfaces. This instrument uses a continuous flow of propane to serve as the counting gas. Alpha and beta particles interacting with the gas in the detector probe produce ionization which can be directly measured by electronic circuitry. The detector window is made of a thin (0.85 mg/cm^2) double-aluminized Mylar and has a total surface area of 51 cm^2 (model AC-21). Since this instrument has multiple high-voltage settings, it can be used to distinguish between alpha and beta contamination. The instrument is calibrated in the alpha mode using a set of thin Pu-239 sources of varying intensities to cover the full response range. Calibration is performed in the beta mode using a ^{90}Sr - ^{90}Y source. PAC-4G-3 instruments are adjusted to an apparent 50% detection efficiency.
- PC-5 -- Nuclear Measurements Corporation* PC-5 is a low background 2π gas-flow proportional counter which was used to analyze smear samples, air samples, and liquid waste samples dried on a planchet. A mixture of argon/methane is used as the counting gas. Samples can be analyzed in the alpha and beta counting modes and count times can be preset as necessary. The PC-5 is calibrated in

®Eberline Instrument Corporation, Sante Fe, NM 87501.

*Nuclear Measurements Corporation, Indianapolis, IN 46218.

the alpha mode using a Pu-239 source and in the beta mode using a ^{90}Sr - ^{90}Y source.

- RGM-2 -- An Eberline® radon gas monitor (RGM-2) was used to monitor the ^{222}Rn concentration in the house, primarily the living room in the #105 duplex, during dismantlement operations. The RGM-2 is a complete, semi-portable instrument used for providing continuous monitoring of radon gas. The instrument incorporates a one-liter scintillation cell (a chamber lined with zinc sulfide phosphor sensitive to alpha particles) for radon gas detection and a microprocessor and printer for data analysis and display. A pump is used for drawing a continuous sample of gas through the scintillation cell at a flow rate of 1 L/min. The microprocessor is programmed to provide data output, in pCi/L. Normal data output is printed hourly and a 24-hour average is printed at the end of each 24-hour monitoring period. The RGM-2 is calibrated using a series of known concentrations of ^{222}Rn generated from a solution containing 2.00 μg of ^{226}Ra obtained from the National Institute of Standards and Technology (formerly National Bureau of Standards). Filtered air was flushed through the ^{226}Ra solution to generate known concentrations of radon gas.
- PRM-5-3 with PG-2 detector -- An Eberline® model PRM-5-3 meter with a PG-2 detector was used to detect gamma radiation in the field. The PG-2 detector consists of a thin NaI (Tl) scintillation crystal (5 cm diameter by 2 mm thick). This instrument can be calibrated using three separate high voltage settings for three different energy regions: 17 keV; 59.5 keV; and 185.7 keV. Using the pulse height analysis mode, the instrument can be used to selectively detect radiation within a given energy range while discriminating against counting photons of other energies outside this window. The PRM-5-3 with PG-2 detector was used in the gross mode rather than the pulse height analysis mode (detection across entire energy spectrum) while surveying ground surface areas on the property.
- Ludlum* 2220 meter with NaI(Tl) or BGO detector -- Subsurface investigations were conducted using a Ludlum 2220 scaler/rate meter and a lead-shielded 3/8" diameter by 3/8" thick sodium iodide (NaI) detector coupled to a photomultiplier tube. Measurements were made at 1/2-ft increments inside a tube down to a depth of about 10 ft. Count times were usually preset at 0.1 minute, however, some one-minute counts were also taken. A 1/2" diameter by 1/2" thick lead-shielded bismuth germanate detector ($\text{Bi}_4\text{Ge}_3\text{O}_{12}$) connected to a photomultiplier tube was also used as an alternate to

*Ludlum Measurements, Inc., Sweetwater, TX 79556.

the sodium iodide detector. Both detectors were designed with a lead end cap and lead foil around the photomultiplier tube so that contamination above and below the detector was not measured.

- Portable Multichannel Analyzer -- A Nuclear Data* (ND-6) portable multichannel analyzer utilizing a 5 cm diameter by 5 cm thick sodium iodide detector encapsulated in a water-tight container was used for conducting surveys in the Union Avenue sewer line. The instrument is battery operated and has both an internal data storage capability and tape cassette storage capability. The instrument was used to identify contamination within the sewer line, not to quantify the amount of an identified radionuclide. An energy calibration of the multichannel analyzer was performed with a ^{226}Ra source prior to use.
- A hyper-pure germanium gamma spectrometry system was used to quantify levels of ^{226}Ra in soil samples collected on the site. The spectrometry system consisted of a germanium detector positioned in a well-shielded cave inside the onsite ANL mobile laboratory. The relative counting efficiency for the ^{226}Ra 186 keV gamma ray and the ^{214}Bi 609 keV gamma ray are 5% and 1% respectively. Appropriate electronics included a high voltage power supply and a PC-based multichannel analyzer equipped with a special board for performing gamma-ray spectrometry functions. The high resolution characteristic of the germanium detector (full-width half maximum at 662 keV is ~2 keV) permits photons relatively close in energy to be resolved into separate photon peaks; for example, the identification and analysis of the low energy 186 keV ^{226}Ra gamma-ray. The spectrometer was calibrated using a standard source of natural uranium uniformly distributed within a silica matrix in a 500 mL Marinelli beaker. A commercially available software package[‡] was used to perform spectral analyses of all samples to provide quantification of the amount of ^{226}Ra in each sample.
- RSS-111 -- A Reuter-Stokes[§] pressurized ion chamber was used at selected locations on the site to measure the ambient gamma-ray exposure rate. The RSS-111 has two different output modes: (1) instantaneous exposure rate ($\mu\text{R}/\text{h}$) readout and (2) integrated exposure (μR). The detector was mounted on a tripod approximately one meter above the ground surface and allowed to integrate the background exposure over a period of 1-2 hours.

*Nuclear Data, Inc., Schaumburg, IL 60196.

‡Gamma Data Reduction (GDR) obtained from The Nucleus, Inc., Oak Ridge, TN 37831.

§Reuter-Stokes, Inc., Edison Park, OH 44087.

4.0 RADIOLOGICAL SURVEY/SAMPLING METHODS AND RESULTS

4.1 Smear Surveys

- Smear surveys were conducted on various surfaces within both duplexes during their dismantlement. Examples of the results of these surveys are provided in Table 1. One of the primary objectives for these surveys was to ensure that significant amounts of loose contamination were not present and available for resuspension in the workplace. The greatest amount of removable surface contamination was found in the basement areas, especially the #105 basement. Smear surveys were also conducted in some of the high traffic areas including the exit checkpoint, the crew trailer lunchroom, and the ANL mobile laboratory. Furniture removed from the duplexes was wiped down and checked for removable surface contamination. The furniture was also directly surveyed for alpha and beta-gamma contamination with a PAC-4G-3 survey instrument. Furniture exhibiting any level of surface contamination above the inherent instrument background response was decontaminated until free from contamination. As a quality assurance effort, cargo bins filled with radioactive waste were also smeared by ANL workers on an unscheduled basis to ensure that contamination levels for shipment of radioactive cargo were not exceeded.

4.2 Air Monitoring and Sample Analyses

- ^{222}Rn monitoring was conducted with an RGM-2 in the living room area of the #105 duplex from 6 October through 10 November 1988 concurrent with dismantling operations. A complete listing of the monitoring data is provided in Table 2. Peak concentrations of ^{222}Rn measured during various periods in October were 11.5-14.2 pCi/L. The U.S. Environmental Protection Agency recommends some level of remedial action when residential dwellings exhibit annual average ^{222}Rn concentrations in excess of 4 pCi/L (50% daughter product equilibrium). The living room area was selected as an appropriate location for monitoring because it was a high traffic area and centralized to the various work activities.
- Particulate air sampling was conducted throughout the work environment on a regular basis from late August through mid-November 1988. The primary purpose of the particulate air sampling program was to determine whether any long-lived alpha particulate activity was suspended in the workplace atmosphere.

TABLE 1 Results of Smear Surveys

Date	Smear Location	Smear Type	Results	
			Alpha Contamination (dis/min per 100 cm ²)	Beta-gamma Contamination (dis/min per 100 cm ²)
9/16/88	#107 Stratford	chimney surface	6	142
9/16/88	#107 Stratford	chimney surface	42	52
9/16/88	#105 Stratford	basement furnace	<1	105
9/16/88	#107 Stratford	furnace box	<1	130
9/19/88	#105 Stratford	floor, SW corner	550	882
9/19/88	#105 Stratford	floor, S. entrance	17	425
9/19/88	#105 Stratford	floor, E.	254	460
9/19/88	#105 Stratford	floor, NW corner	825	1580
9/19/88	#105 Stratford	floor, mid. dining rm.	550	910
9/19/88	#105 Stratford	floor, entrance	658	1097
9/19/88	#105 Stratford	floor, W. kitchen	350	700
9/19/88	#105 Stratford	basement, S. room	92	222
9/19/88	#105 Stratford	basement, doorway to S. room	588	935
9/19/88	#105 Stratford	basement	46	182
9/20/88	#105 Stratford	basement	42	187
9/20/88	#105 Stratford	basement, NW corner	212	440
9/20/88	#105 Stratford	basement, N. section	79	240
9/20/88	#105 Stratford	basement	129	322
9/20/88	#105 Stratford	basement	1271	1978
9/20/88	#105 Stratford	basement, S. room	42	192
9/20/88	#105 Stratford	basement	912	1345
9/20/88	#105 Stratford	basement, water tank	904	1625
9/20/88	#105 Stratford	basement sink	704	1500
10/2/88	#107 Stratford	living room chair	4	125
10/3/88	#107 Stratford	living room chair	4	142
10/3/88	#107 Stratford	chest of drawers	8	140
10/3/88	#107 Stratford	dresser top	8	135
10/4/88	#105 Stratford	ledge	17	135
10/5/88	#107 Stratford	furniture	4	130
10/5/88	#107 Stratford	furniture	42	112
10/8/88	#105 Stratford	garage floor back	8	148
10/8/88	#105 Stratford	garage floor front	262	515

TABLE 1 (Cont'd)

Date	Smear Location	Smear Type	Results	
			Alpha Contamination (dis/min per 100 cm ²)	Beta-gamma Contamination (dis/min per 100 cm ²)
10/8/88	#105 Stratford	garage floor	38	205
10/10/88	#105 Stratford	roof slate	38	282
10/10/88	#105 Stratford	roof slate	8	155
10/10/88	#105 Stratford	roof slate	8	160
10/11/88	#105 Stratford	post	4	160
10/11/88	#105 Stratford	'hot' keys	25	142
10/11/88	#105 Stratford	3rd floor	17	175
10/11/88	#105 Stratford	3rd floor	38	162
10/11/88	#105 Stratford	3rd floor	38	180
10/13/88	#105 Stratford	3rd floor	104	302
11/3/88	#105 Stratford	LSA bins	4	175
1/11/89	#ME8	workbench	4	140
1/11/89	#ME8	floor by door	4	125
1/28/89	#ME8	S. countertop	8	120
1/28/89	#ME8	N. floor	<1	107
1/29/89	#ME8	S. Rhodes' boots	4	132
3/3/89	#ME8	table	4	137
3/3/89	#ME8	S. benchtop	4	115
3/3/89	#ME8	E. ½ floor	4	135
3/3/89	#ME8	W. ½ floor	4	135
3/30/89	#112 Stewart	rafter	<1	4375
3/30/89	#112 Stewart	ledge	1458	6
3/30/89	#112 Stewart	plate, W. corner	2083	25
3/31/89	#ME8	countertop	<1	135
3/31/89	#ME8	floor	4	130

- Notes: (1) Alpha background for PC-5: 0.5 cts/min or 2 dis/min per 100 cm².
 (2) Beta-gamma background for PC-5: 60 cts/min or 150 dis/min per 100 cm².
 (3) An overall counting efficiency of 24% is used to convert alpha counts per minute to dis/min using the PC-5 gas-flow proportional counter. The overall efficiency was determined from the following: geometry factor 0.43; backscatter factor 1.00; self-absorption assumed to be 1.00; and the window air factor 0.55.
 (4) An overall counting efficiency of 40% is used to convert beta counts per minute to dis/min using the PC-5 gas-flow proportional counter. The overall efficiency was determined from the following: geometry factor 0.43; backscatter factor 1.10; self-absorption 1.00; and the window air factor 0.85.

**TABLE 2 Results of Continuous ^{222}Rn
Monitoring in Living Room Area
of #105 Duplex**

Monitoring Period (1988)	Average ^{222}Rn Concentration (pCi/L)
October 6-7	8.1
October 8-10	14.2
October 11-12	8.4
October 13-14	9.3
October 15-17	6.7
October 18-19	5.8
October 20-21	11.5
October 22-24	7.6
October 25-26	13.9
October 27-28	12.6
October 29-30	13.0
October 31 - November 1	6.2
November 2-3	4.5
November 4-5	3.9
November 6-7	2.7
November 8-9	3.1
November 10	2.7

- Notes: (1) All ^{222}Rn monitoring was performed using an Eberline® Radon Gas Monitor, RGM-2.
- (2) Practical lower limit of detection -- 1.0 pCi/L.
- (3) The uncertainty in the measured concentrations shown above is estimated to be $\pm 10\%$.

During the dismantlement operations, the greatest radiological concern was the potential for worker inhalation of ^{226}Ra contamination. Various engineering controls were implemented by the Contractor, including dust abatement techniques and forced ventilation throughout the structure. Workers were required to wear air helmets or full-face respirators to protect themselves from the potential airborne hazard.

Particulate air samples were collected using a high volume air sampler and LB-5211 cellulose fiber filter paper. The sample flow rate was $40 \text{ m}^3/\text{h}$ and the collection efficiency at this flow rate for particles with an AMAD of $0.3 \mu\text{m}$ is $>99\%$. At the end of the sampling period (generally 0.5-2.0 hours), the filter was removed from the sampler and brought back to the mobile laboratory for analysis. A 10% portion of the filter paper was removed and counted for both alpha and beta-gamma activity in the PC-5 gas-flow proportional counter. The presence of any radium activity on the filter paper was determined seven days post sampling so that ample time would have elapsed to permit the decay of short-lived ^{222}Rn and ^{220}Rn daughter products. Results of the particulate air sample analyses are provided in Table 3. The concentration of long-lived alpha particulate activity ranged from $<1.5\text{E-}4 \text{ pCi/L}$ to $2.5\text{E-}2 \text{ pCi/L}$.

4.3 Laundry Waste Tank Sample Analyses

- The laundry waste tank was sampled prior to its contents being discharged to the sanitary sewer system. A one liter sample from the laundry waste tank was collected by the onsite Contractor after at least five minutes of tank recirculation. The 1000 mL sample was reduced to 100 mL volume by evaporation. A one milliliter aliquot was taken and dried on a 47 mm diameter stainless steel planchet and then analyzed using the PC-5 gas-flow proportional counter. The results of the sample analyses were expressed in terms of a gross alpha activity concentration ($\mu\text{Ci/mL}$) in the laundry wastewater. The results of all laundry waste tank analyses are listed in Table 4. The discharge criteria of ^{226}Ra are based on a maximum permissible concentration of $4\text{E-}7 \mu\text{Ci/mL}$ or a total batch discharge quantity of $0.1 \mu\text{Ci}$, whichever criterion can be met (Appendix F). In cases where neither discharge criterion could be achieved, additional filtration of the tank contents was required followed by additional sampling and analysis. Filters used to remove particulate matter in the laundry wastewater were changed regularly, especially after heavy use to remove contaminants, and shipped offsite along with other contaminated material.

4.4 Union Avenue Sewer Line Investigations

- Sewer line survey -- A series of measurements were made inside the Union Avenue sewer line both downstream and upstream of the junction with Stratford Avenue (Table 5 and Fig. 10). Survey measurements were made using a 2 inch diameter by 2 inch thick sodium iodide detector coupled to a count rate meter (PRM-5-3).

TABLE 3 Results of Particulate Air Sample Analyses

Sample Collection Date	Sample Location	Project Phase	Long-Lived Alpha Concentration pCi/L \pm σ $\times 10^{-4}$
08-25-88	#107 Duplex Basement	Ambient Measurement	<1.5
08-30-88	#105 Duplex Roof Area	Dismantlement of #105 Chimney	<1.5
09-20-88	#105 Duplex Living Room	Ambient Measurement	<1.5
09-21-88	#107 Duplex Third Floor	Destructive Activities on the Third Floor of #107 Duplex	35 \pm 6
09-21-88	Outdoors at SE Property Fenceline	Destructive Activities on the Third Floor of #107 Duplex	<1.5
09-29-88	#107 Duplex First Floor	Destructive Activities on the First Floor of #107 Duplex	<1.5
10-06-88	Inside #105 Garage NE Corner	Floor Scabbling Activities	23 \pm 2.5
10-06-88	Inside #105 Garage West Side	Floor Scabbling Activities	6.7 \pm 1.5
10-07-88	Work Area Inside #105 Garage	Garage Dismantlement Activities	7.8 \pm 4.8
10-08-88	#105 Duplex Living Room	Ambient Measurement	<1.5
10-10-88	#105 Duplex Third Floor	Dismantlement of #105 Third Floor	160 \pm 20
10-10-88	#105 Duplex Third Floor	Dismantlement of #105 Third Floor	130 \pm 20
10-11-88	#105 Duplex Third Floor	Dismantlement of #105 Third Floor	42 \pm 10
10-11-88	#105 Duplex Third Floor	Dismantlement of #105 Third Floor	87 \pm 14

TABLE 3 (Cont'd)

Sample Collection Date	Sample Location	Project Phase	Long-Lived Alpha Concentration $\text{pCi/L} \pm 1\sigma$ $\times 10^{-4}$
10-12-88	#105 Duplex Third Floor	Dismantlement of #105 Third Floor	85±8
10-12-88	#105 Duplex Third Floor	Dismantlement of #105 Third Floor	100±20
10-13-88	#105 Duplex Third Floor	Dismantlement of #105 Third Floor	130±20
10-13-88	#105 Duplex Third Floor	Dismantlement of #105 Third Floor	130±10
10-14-88	#105 Duplex Third Floor	Dismantlement of #105 Third Floor	83±19
10-15-88	#107 Duplex Third Floor	Dismantlement of #107 Third Floor	10±5
10-15-88	#107 Duplex Third Floor	Dismantlement of #107 Third Floor	<1.5
10-17-88	#107 Duplex Third Floor	Dismantlement of #107 Third Floor	10±5
10-17-88	#107 Duplex Third Floor	Dismantlement of #107 Third Floor	5.8±4.3
10-18-88	#107 Duplex Third Floor	Dismantlement of #107 Third Floor	1.7±3.1
10-18-88	#107 Duplex Third Floor	Dismantlement of #107 Third Floor	5.8±4.3
10-19-88	#107 Duplex Third Floor	Dismantlement of #107 Third Floor	3.9±3.7
10-19-88	#107 Duplex Third Floor	Dismantlement of #107 Third Floor	21±7
10-20-88	#107 Duplex Third Floor	Dismantlement of #107 Third Floor	3.9±3.8
10-21-88	#107 Duplex Third Floor	Dismantlement of #107 Third Floor	<1.5
10-22-88	#107 Duplex Second Floor	Dismantlement of #107 Second Floor	7.3±3.0

TABLE 3 (Cont'd)

Sample Collection Date	Sample Location	Project Phase	Long-Lived Alpha Concentration $\text{pCi/L} \pm \sigma$ $\times 10^{-4}$
10-24-88	#107 Duplex Second Floor	Dismantlement of #107 Second Floor	21±5
10-25-88	#105 Duplex First Floor	Dismantlement Activities on #105 Duplex Second Floor	19±5
11-01-88	#105 Duplex First Floor	Dismantlement of #105 Second Floor	5.4±2.8
11-02-88	#105 Duplex First Floor	Dismantlement of #105 Second Floor	5.7±2.6
11-03-88	#105 Duplex First Floor	Dismantlement of #105 Second Floor	250±10
11-04-88	#105 Duplex First Floor	Dismantlement of #105 First Floor	100±10
11-05-88	#105 Duplex First Floor	Dismantlement of #105 First Floor	35±6
11-07-88	#105 Duplex First Floor	Dismantlement of #105 First Floor	18±4
11-08-88	#105 Duplex First Floor	Dismantlement of #105 First Floor	160±10
11-09-88	#105 Duplex First Floor	Dismantlement of #105 First Floor	10±3
11-10-88	#105 Duplex First Floor	Dismantlement of #105 First Floor	6.7±2.2

TABLE 3 (Cont'd)

Sample Collection Date	Sample Location	Project Phase	Long-Lived Alpha Concentration $\text{pCi/L} \pm 1\sigma$ $\times 10^{-4}$
11-11-88	#105 Duplex First Floor	Dismantlement of #105 First Floor	14 \pm 3
11-14-88	Entrance Way #105 Duplex	Dismantlement of #105 First Floor	42 \pm 5

- Notes: (1) All particulate air samples were obtained using a high volume air sampler (40 m³/hr) and an LB-5211 cellulose fiber filter.
- (2) Samples were collected over a period of 1 hour and analyzed using a gas-flow proportional counter in both the alpha and alpha plus beta counting modes 7 days post sampling.
- (3) The detection limit of 1.5E-4 pCi/L is based on a 2-minute analysis and an alpha background count rate of 0.5 counts/minute.
- (4) 1 σ ~ represents the uncertainty in the measurement due to counting statistics.

TABLE 4 Results of the Laundry Waste Tank Sample Analyses

Sample Analysis Date	Sample Number	Gross Alpha Activity Concentration $\mu\text{Ci/mL} \pm 1\sigma$ $\times 10^{-8}$	Total Alpha Activity in Tank $\mu\text{Ci} \pm 1\sigma$
09-13-88	001	31 \pm 7	0.75 \pm 0.17
09-13-88	002	<8	<0.2
09-15-88	003	18 \pm 5	0.44 \pm 0.13
09-20-88	004	59 \pm 10*	1.44 \pm 0.23
09-20-88	004A	59 \pm 10*	1.46 \pm 0.23
09-20-88	004B	12 \pm 7	0.31 \pm 0.17
09-22-88	005	75 \pm 10*	\pm 0.23
09-22-88	005A	17 \pm 6	\pm 0.16
09-23-88	006	<8	<0.2
09-23-88	007	59 \pm 8*	1.42 \pm 0.21
09-24-88	007A	81 \pm 10*	2.00 \pm 0.23
09-26-88	007B	7.7 \pm 5.5	0.18 \pm 0.14
09-28-88	008	<8	<0.2
09-29-88	009	<8	<0.2
09-30-88	010	10 \pm 5	0.25 \pm 0.12
10-07-88	011	<8	<0.2
10-10-88	012	<8	<0.2
10-14-88	013	26 \pm 6	0.63 \pm 0.16
10-19-88	014	16 \pm 5	0.40 \pm 0.12
10-21-88	015	<8	<0.2
10-26-88	016	<8	<0.2
10-31-88	017	<8	<0.2
11-01-88	018	31 \pm 6	0.77 \pm 0.15
11-03-88	019	16 \pm 5	0.39 \pm 0.13

TABLE 4 (Cont'd)

Sample Analysis Date	Sample Number	Gross Alpha Activity Concentration $\mu\text{Ci/mL} \pm 1\sigma$ $\times 10^{-8}$	Total Alpha Activity in Tank $\mu\text{Ci} \pm 1\sigma$
11-05-88	020	19 ± 6	0.48 ± 0.15
11-09-88	021	8.6 ± 4.1	0.21 ± 0.10
11-14-88	022	< 8	< 0.2
11-17-88	023	< 8	< 0.2
11-19-88	024	10 ± 6	0.25 ± 0.14
11-29-88	025	11 ± 6	0.28 ± 0.14
11-29-88	026	< 8	< 0.2
12-03-88	027	1.4 ± 6	0.36 ± 0.15
12-06-88	028	< 8	< 0.2
12-08-88	029	< 8	< 0.2
12-20-88	030	< 8	< 0.2
02-01-89	031	< 8	< 0.2
02-14-89	032	8.6 ± 7.0	0.21 ± 0.18
02-16-89	033	34 ± 7	0.81 ± 0.18
02-17-89	034	$95 \pm 10^*$	2.30 ± 0.26
02-17-89	034A	$44 \pm 15^*$	1.10 ± 0.37
02-17-89	034B	26 ± 7	0.60 ± 0.17
02-18-89	035	$77 \pm 17^*$	1.90 ± 0.42
02-21-89	035A	37 ± 14	0.90 ± 0.33
02-21-89	036	< 8	< 0.2
02-23-89	037	15 ± 6	0.37 ± 0.14
02-25-89	038	29 ± 7	0.71 ± 0.17
02-28-89	039	33 ± 7	0.81 ± 0.17

TABLE 4 (Cont'd)

Sample Analysis Date	Sample Number	Gross Alpha Activity Concentration $\mu\text{Ci/mL} \pm 1\sigma$ $\times 10^{-8}$	Total Alpha Activity in Tank $\mu\text{Ci} \pm 1\sigma$
03-01-89	040	34 \pm 7	0.84 \pm 0.18
03-02-89	041	10 \pm 5	0.25 \pm 0.13
03-04-89	042	15 \pm 6	0.33 \pm 0.14

- Notes: (1) The letter designation after the Sample Number refers to a follow-up sample analysis after further processing of tank contents.
- (2) Asterisk (*) indicates activity concentration in the tank are above discharge criteria.
- (3) The detection limit of $8\text{E-}8 \mu\text{Ci/mL}$ is based on a 20-minute analysis and an alpha background count rate of 0.8 counts/min.
- (4) Samples were analyzed in the alpha mode of a gas-flow proportional counter. Alpha activity was determined from the net alpha count rate and an overall counting efficiency of 27%.
- (5) The release criteria for ^{226}Ra is based on a maximum permissible concentration of ^{226}Ra of $4\text{E-}7 \mu\text{Ci/mL}$ or a total batch discharge quantity of $0.1 \mu\text{Ci}$, whichever criterion can be met.
- (6) 1σ ~ represents the uncertainty in the measurement due to counting statistics.

The detector was encased in a protective capsule and pulled slowly through the 8 inch diameter sewer line while measurements were continuously made. The above ground background count rate for this instrument ranged from 1500-2000 cts/min. The measured count rate inside of the Union Avenue sewer line downstream (south) of the junction point with Stratford Avenue (Fig. 11) was 2500-4000 cts/min. Given the natural radioactivity in soil and the sewer line pipe itself, the factor of up to two increase in the measured count rate in the sewer line is assumed to be attributable to the presence of natural radioactivity and not related to any past activities at the Stratford Avenue property.

TABLE 5 Measurements Made in Union Avenue Sewer Line

- 1.0 Measurements made with PRM-5-3 survey meter and sodium iodide detector along the north and south sections of the Union Avenue sewer line at the junction with Stratford Avenue

North section of sewer line: 2500-4000 cts/min
 5000-8000 cts/min (17 ft section 95 ft
 north of Union/Stratford
 manhole)
 1500-2000 cts/min (above ground background
 count rate)

South section of sewer line: 2500-4000 cts/min
 1500-2000 cts/min (above ground background
 count rate)

- 2.0 Measurements made with ND-6 multichannel analyzer and sodium iodide detector within and south of the 17 ft section of sewer line requiring further investigation

Location (in feet) North of the Union/Stratford Manhole	609 keV gross cts/sec	1460 keV gross cts/sec	ratio 609/1460
95	14.7±0.2	4.9±0.1	3.0±0.1
90	13.6±0.2	4.8±0.1	2.8±0.1
88	13.6±0.2	4.6±0.1	3.0±0.1
85	13.1±0.2	4.5±0.1	2.9±0.1
80	12.1±0.1	4.1±0.1	3.0±0.1
78	11.9±0.2	4.1±0.1	2.9±0.1
60	11.7±0.2	3.8±0.1	3.0±0.1
45	11.4±0.1	4.1±0.1	2.8±0.1
16	11.2±0.1	3.7±0.1	3.0±0.1
	12.5±0.1	4.2±0.1	3.0±0.1

±values refer to the counting uncertainties (1σ) associated with the measurements

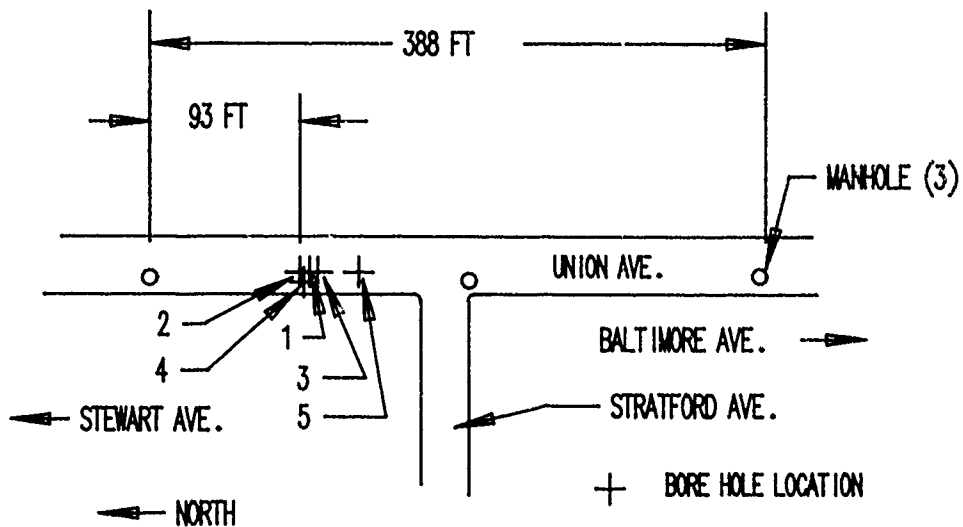


FIGURE 10 Map of the Section of Union Avenue Sewer Line Surveyed Including Borehole Locations



FIGURE 11 Lowering Detector Down Union Avenue Manhole at Stratford Avenue Junction

A 188 ft section of Union Avenue sewer line, located upstream (north) of the Stratford Avenue junction point, was also surveyed. A 17 ft section of sewer line located 95 ft north of the manhole at the Union/Stratford junction was identified as exhibiting radiation levels in excess of those measured anywhere else in the Union Avenue sewer line. Within this 17 ft long section of pipe, the radiation count rate varied from 4000 to 8000 cts/min. The measured count rate in the other sections of the north sewer line were only 2500 to 4000 cts/min. To further investigate (Fig. 12) the doubling in the measured count rate, the sodium iodide detector was coupled to a portable multichannel analyzer so that some information about the energy spectrum of the detected gamma rays could be obtained.

Within the 17 ft section of sewer line, a measurable increase in the size of the 609 keV (Bi-214) and 1460 keV (K-40) gamma-ray photopeaks was observed. Bismuth-214 is a daughter product belonging to the $^{238}\text{U}/^{226}\text{Ra}$ decay chain and is found naturally in soil. Potassium-40 is also naturally-occurring in soil although it is not a part of any radioactive decay chain. The ratio of the 609 keV photopeak size to the 1460 keV photopeak size was fairly constant both within the 17 ft section of sewer line and within other sections of the north sewer line. It is not uncommon to observe a 30%



FIGURE 12 Workers Measuring Radioactivity in the Union Avenue Sewer Line



FIGURE 13 Borehole Drilling Along Union Avenue

variability in the levels of these naturally-occurring radionuclides. This was interpreted to be indicative of the natural presence of radioactivity in soil or in the sewer line itself.

- Borehole sampling/analysis and logging -- Boreholes #1 through #4 were drilled by the USACOE along the 17 ft section of Union Avenue sewer line identified for further investigation, each to a depth of approximately 10 ft (Fig. 13). Borehole #5 was drilled adjacent to the 17 ft section for the purpose of making comparative measurements. All of the boreholes were drilled using 8-inch diameter hollow stem augers. Soil samples were collected using a 1.5 ft long, 3-inch inner diameter split spoon in conjunction with a 300 lb hammer. Each sample was carefully removed from the spoon, placed in a plastic bag, assigned a sample number, and sent to the onsite ANL mobile laboratory for analysis. Individual samples were prepared in Marinelli beakers and counted for 20 minutes on a high resolution gamma-ray spectrometry system. The measured ^{226}Ra and ^{40}K concentrations in all of the soil samples collected and analyzed from the five boreholes is consistent with natural levels for these radionuclides. However, there is a difference between the ^{232}Th concentrations measured in the samples collected from boreholes #1 through #4 and borehole #5. The measured ^{232}Th concentration in the soil samples collected from borehole #5, which is outside the 17 ft section of sewer line, is significantly below those ^{232}Th concentrations measured in the

samples collected from boreholes #1 through #4. From the available data, this is the only indication of any difference in the radionuclide concentrations within and outside the 17 ft section of Union Avenue sewer line under investigation. The results of all borehole sample analyses are provided in Tables D.1 and D.2 of Appendix D.

Borehole logging was conducted at various depths below grade for each of the five boreholes drilled. All borehole logging was performed using a 2-inch diameter by 2-inch thick sodium iodide detector coupled to a portable battery-operated multichannel analyzer. The logging procedure involved lowering the detector along the vertical axis of the borehole. Measurements were made at various borehole depths. Gamma-ray spectra were acquired during a 3-minute acquisition and stored on microcassette. Each acquired spectrum was visually inspected for the possible presence of ^{226}Ra contamination. A ratio of the 609 keV to 1460 keV gamma-rays greater than three would be expected for elevated levels of ^{226}Ra . No anomalies in the spectral data were identified. Logging results provided in Table 6 do not show a significant change in the ratio of the Bi-214 and K-40 measured count rates at any of the logging depths for any of the five borehole locations.

Based on the analysis of the borehole samples collected and the borehole logging that was performed, the area of elevated measured count rate in the Union Avenue sewer line was determined to be due to the variations in the level of naturally-occurring radioactivity.

TABLE 6 Results of Borehole Logging Along Union Avenue

	609 keV gross cts/sec	1460 keV gross cts/sec	ratio 609/1460
Borehole no. 1			
grade	10.7±0.2	15.9±0.3	0.67±0.02
4'	15.4±0.3	6.1±0.2	2.52±0.09
8'	13.7±0.3	4.4±0.2	3.11±0.13
Borehole no. 2			
grade	11.6±0.3	6.9±0.2	1.68±0.06
6'	15.5±0.3	NA	NA
8'	13.7±0.3	4.7±0.2	2.91±0.12
9'	13.8±0.3	5.5±0.2	2.51±0.09
Borehole no. 3			
grade	10.6±0.2	4.6±0.2	2.30±0.10
4'	15.0±0.3	5.8±0.2	2.59±0.09
8'	12.5±0.3	4.3±0.2	2.91±0.12
9'	13.9±0.3	5.0±0.2	2.78±0.11
Borehole no. 4			
grade level	11.5±0.3	4.7±0.2	2.45±0.11
4'	18.0±0.3	7.7±0.2	2.34±0.07
6'	16.9±0.3	6.3±0.2	2.68±0.09
7'	15.2±0.3	5.4±0.2	2.81±0.10
Borehole no. 5			
grade level	10.5±0.2	4.5±0.2	2.33±0.10
5'	6.1±0.2	3.8±0.1	1.61±0.05
8'	9.6±0.2	4.9±0.2	1.96±0.08
9'	10.8±0.2	6.4±0.2	1.69±0.06

Note: • Five holes were drilled near a 17 ft section of Union Avenue sewer line located between the north manhole and the junction with Stratford Avenue to gain reassurance that the Union Avenue sewer line was not contaminated with radioactive materials. The 609 keV peak identified is due to Bi-214 and the 1460 keV peak is due to K-40.

- NA ~ data not available.
- ± values refer to the counting uncertainties (1σ) associated with the measurements.

5.0 RESULTS OF SOIL TUBE MEASUREMENTS

5.1 Description of General Technique

The spatial distribution of ^{226}Ra soil contamination on the property, and along the adjacent properties was determined so that an estimate could be made of the total volume of contaminated soil which would need to be removed and shipped offsite as contaminated waste. The basic technique involved driving 1-inch diameter tubes into the ground to a depth of up to 10 ft, depending on soil penetrability. A small 3/8" diameter by 3/8" thick sodium iodide detector, lead shielded at the end to better define the lateral viewing geometry, was connected to a Ludlum 2220 scaler/ratemeter and measurements were made at 1/2 ft increments as the detector was lowered down the tube. Some tube holes were logged using the bismuth germinate detector (1/2" diameter by 1/2" thick) as a test of its utility for such applications and to reduce the time required to log the soil tubes. The count time for each measurement was usually a tenth of a minute although in some circumstances longer count times of one minute were used. Soil samples were obtained and analyzed at various locations on the property where subsurface logging data were also available so that an approximate correlation between the logging data and the cleanup criterion of 5 pCi/g ^{226}Ra above background could be established.

Using the sodium iodide detector, the measured count rate corresponding to a ^{226}Ra concentration in excess of the cleanup criterion was determined to be 400 cts/min for the first one foot below grade and 800 cts/min below one foot. For the bismuth germinate detector, the corresponding values were 1300 cts/min and 2000 cts/min respectively. The two different correlation coefficients can be attributed to the difference in the solid angle viewed by the detector near the ground surface and at depths greater than one foot. The difference in correlation coefficients between the two different detectors, sodium iodide versus bismuth germinate, is due to the fact that bismuth germinate, with its larger size and higher atomic number, has a greater detection efficiency for low and intermediate energy photons.

Logging data collected from hole location number 378 near the 112 Stewart garage is shown in Fig. 14 for both the bismuth germinate and sodium iodide detectors. This hole location is shown in Fig. 15. Although the shape of the two curves is nearly identical, the bismuth germinate detector shows an enhanced sensitivity as demonstrated by the higher count rates. The dashed horizontal line in each graph corresponds to the established cleanup criterion in excess of 1 ft below grade. This particular area was identified as having a significant amount of ^{226}Ra contamination. The effective viewing radius for the 1764 keV ^{214}Bi gamma-ray in moderately compact soil is probably in the range of about 2 ft. For the lower energy daughter products the effective range would be less. This subsurface investigation technique is useful in identifying areas of contamination which might otherwise be missed by surface measurements. The more tubes which can be driven into the ground and the closer that they are positioned to one another the better the probability of identifying contamination and characterizing its distribution. Drawings of the site zones and regions where subsurface investigations were performed and the data from all soil tube holes can be found in Appendix C.

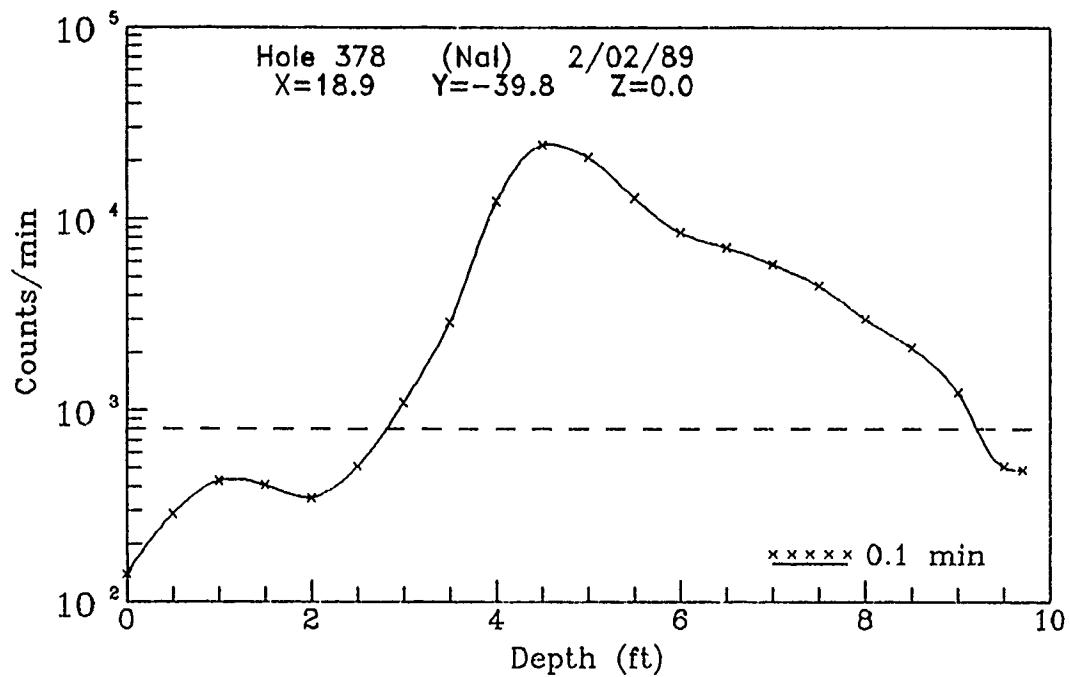
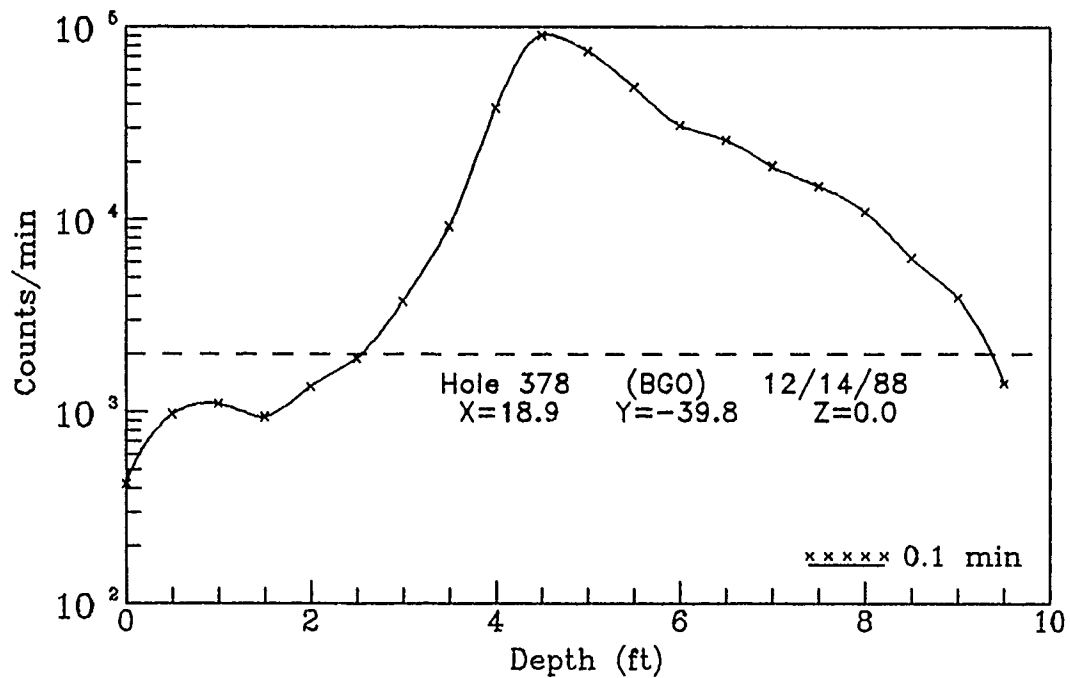


FIGURE 14 Data from 112 Stewart, North of the Garage Using the Sodium Iodide and Bismuth Germinate Detectors

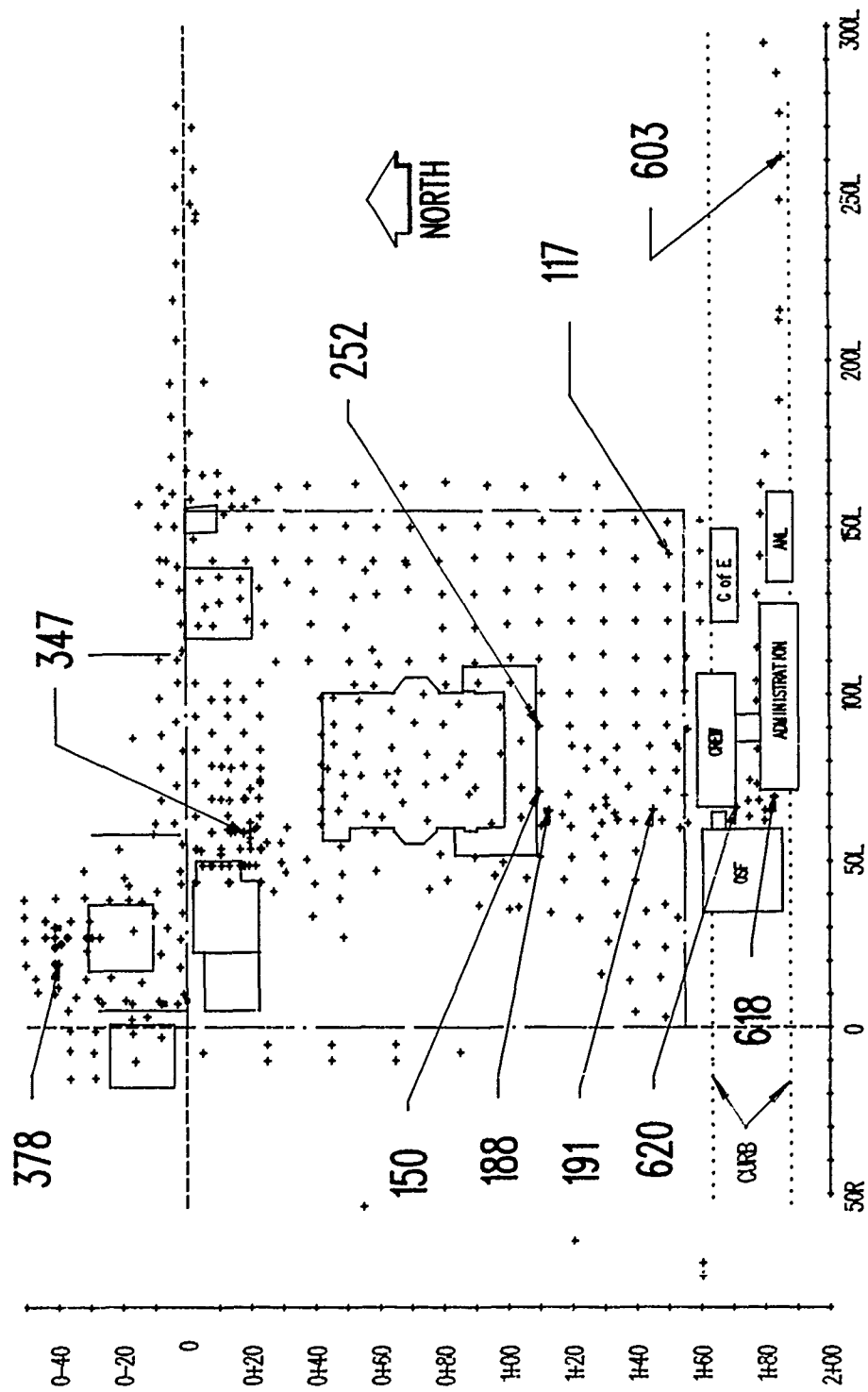


FIGURE 15 Overview Map Showing Locations of Subsurface Investigations

5.2 Contamination Depth Profile on the Property

Over 450 tubes, up to ten feet in length, were driven into the ground at spacings of about 5-20 ft. Tubes were also driven through the basement foundation, the front porches, adjacent properties, and through the asphalt on Stratford Avenue in close proximity to the sewer line. A diagram showing the locations of all the tube holes is provided in Fig. 15. Each crossmark (+) represents an individual tube hole location.

A lightweight, gasoline-powered jackhammer was used to drive the tubes into the ground (Fig. 16). In some cases the tubing could not be driven into the ground the entire length and had to be cut a few inches above grade to facilitate the logging procedure (Fig. 17). An illustration of the tube, in two five foot sections, is shown in Fig. 18. However, the soil tubes used at the Lansdowne site were a single piece ten foot in length. The photograph in Fig. 19 shows workers logging a hole, the white container placed over the hole is used as a referencing marker.

The graph in the top left corner of Fig. 20 shows contamination extending from grade level down to a depth of at least 6 ft for a series of measurements conducted near



FIGURE 16 Workers Driving 1-inch Diameter Tube in Ground for Subsurface Investigations



FIGURE 17 Workers Cutting Excess Tubing Prior to Subsurface Measurements

the #105 duplex garage (hole number 347 in Fig. 15). The dashed line in the figure corresponds to 800 cts/min. The area was subsequently excavated. To verify that this area was properly remediated, other tubes were driven into the ground 5 ft below the excavated grade and logging data were collected. The data shown in the top right graph reveal some activity above the 800 cts/min limit at the 2-4 ft depth. A 3 ft hole was dug around the tube in an effort to sample and analyze the soil showing signs of elevated activity. Analysis of these soil samples revealed elevated levels of naturally-occurring uranium and thorium (samples 22-S-298 through 22-S-301 in Tables 9, 10, and 11). The bottom two graphs in Figure 20 show that activity was still present at depths of 3-5 ft after the soil samples had been removed from 1.5 ft to 3 ft. The ^{226}Ra concentration was below the clean-up criterion of 5 pCi/g, therefore, no further remediation was necessary.

The results of some typical subsurface investigations conducted in the front yards of the duplex are shown in Fig. 21. The upper left corner graph shows some contamination present in the first 1 ft of soil below grade (count rate in excess of 400 cts/min). Below 1 ft, the count rate is less than the corresponding cleanup criterion (800 cts/min). The upper right corner graph shows no evidence of contamination from an area east of the #107 duplex driveway. An area in the front yard of the #105 duplex (bottom left graph) shows some evidence of contamination present from grade to approximately 2 ft. The lower right corner graph shows some contamination from grade to 1 ft for a location in the front yard of the #105 duplex. Soil samples were collected and analyzed from the grade-0.2 ft (sample 22-S-189) and 0.2-0.4 ft (sample 22-S-190) levels for this particular task. Results of these analyses showed ^{226}Ra concentrations of

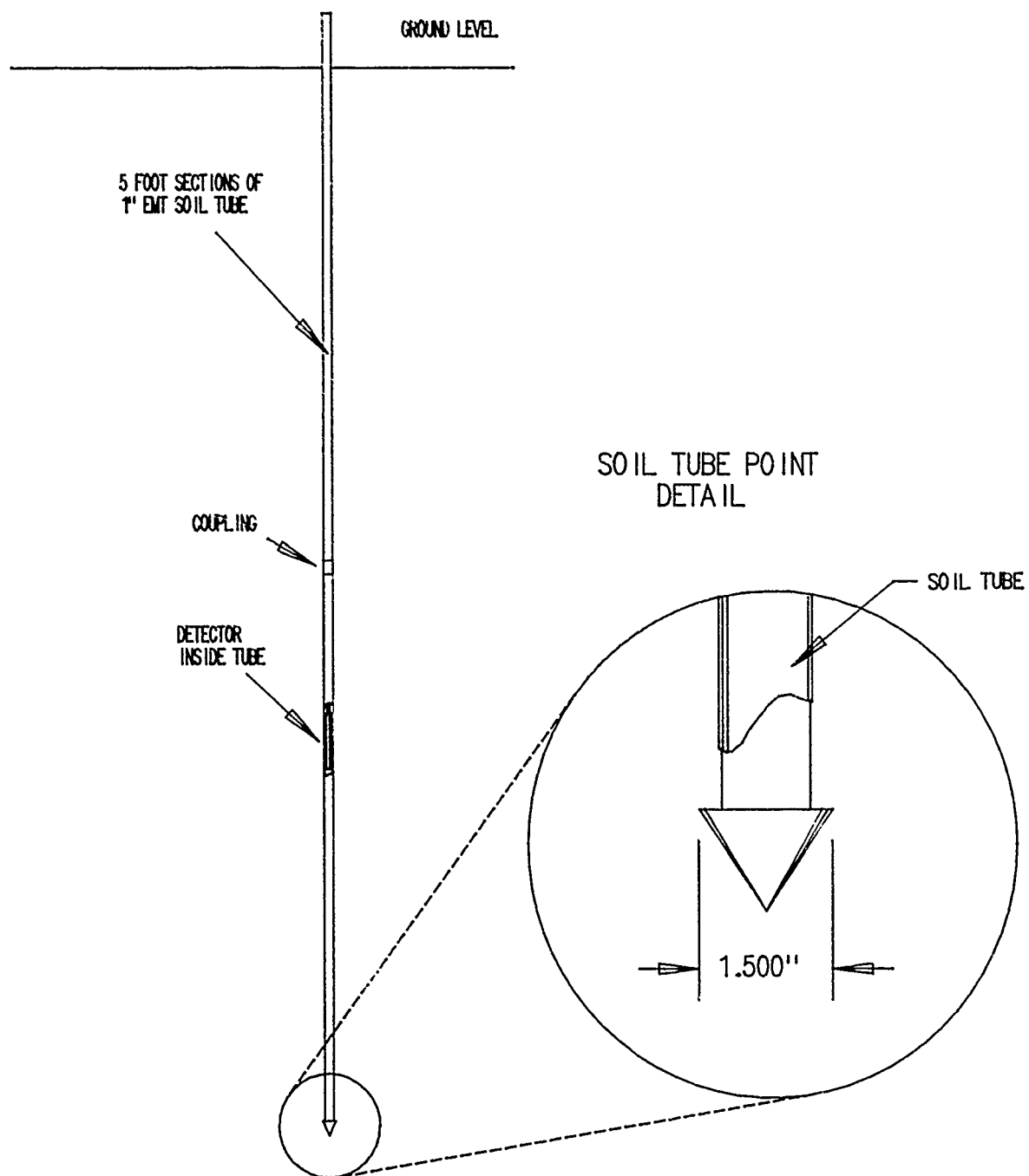


FIGURE 18 Tube and Logging Detector

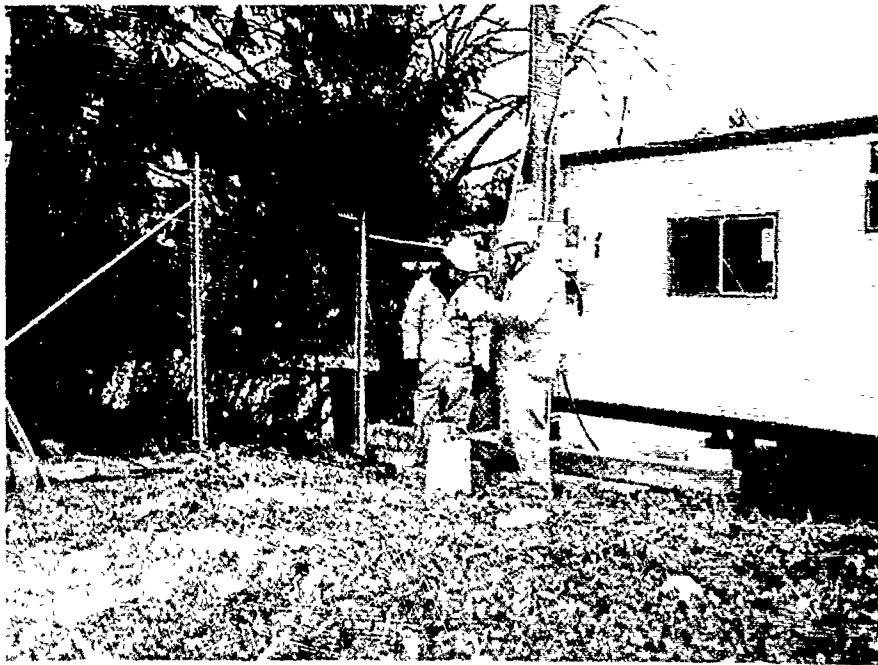


FIGURE 19 Subsurface Soil Investigation Measurements

14 pCi/g and 10 pCi/g respectively (Table 10, aged, 609 keV energy line). This demonstrated that for the first foot of soil below grade, the soil concentration coefficient of 400 cts/min needs to be used in determining the presence of soil contamination. The logging data from the soil tubes can be found in Appendix C. The analysis of soil samples taken near the soil tubes can be found in Appendix D, Tables D.3 and D.4.

5.3 Soil Tube Measurements Along the Stratford Avenue Sewer Line

A preliminary radiological assessment of the Stratford Avenue sewer line was conducted to determine whether the line was internally contaminated with radioactive material. Sludge samples were collected at two different manholes, both downstream of the duplex lateral connecting with the Stratford Avenue main, and analyzed for the presence of radioactivity. The results of these sludge sample analyses indicated the presence of sewer line contamination; however the extent of the contamination was not known. *In-situ* measurements using the portable spectrometry system were not possible due to an inadequate sewer line flow. Subsurface investigations, using the soil tube and logging procedure, were employed to provide more definitive information regarding the radiological status of the Stratford sewer line. Approximately two dozen tubes were driven through the asphalt to a depth in close proximity to the sewer line. In one case, a tube was driven through the sewer line.

The top two graphs in Fig. 22 reveal the presence of contamination in or around the Stratford Avenue sewer line. The upper left graph shows contamination near the

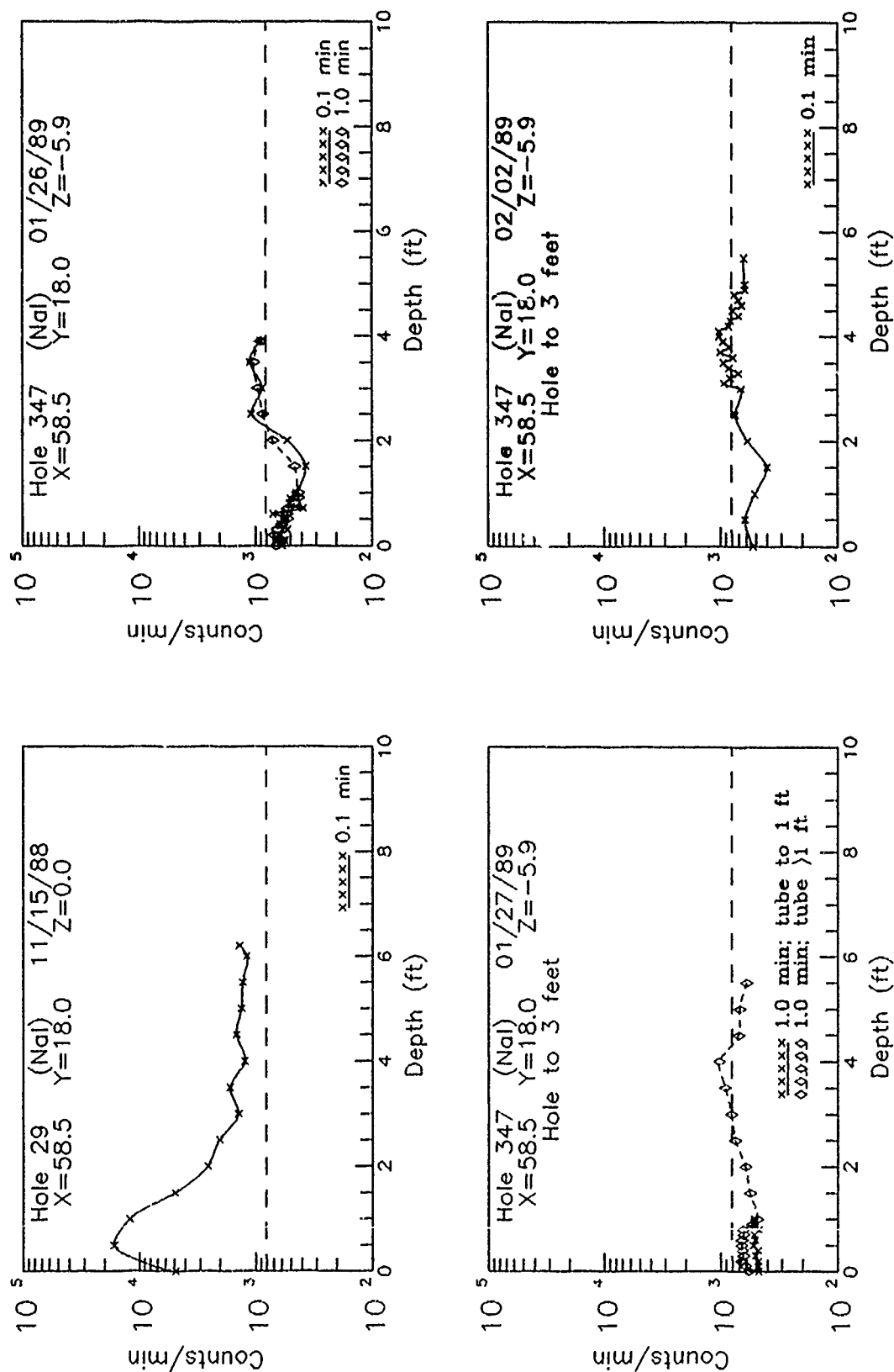


FIGURE 20 Results of Subsurface Investigations Near the #105 Duplex Garage

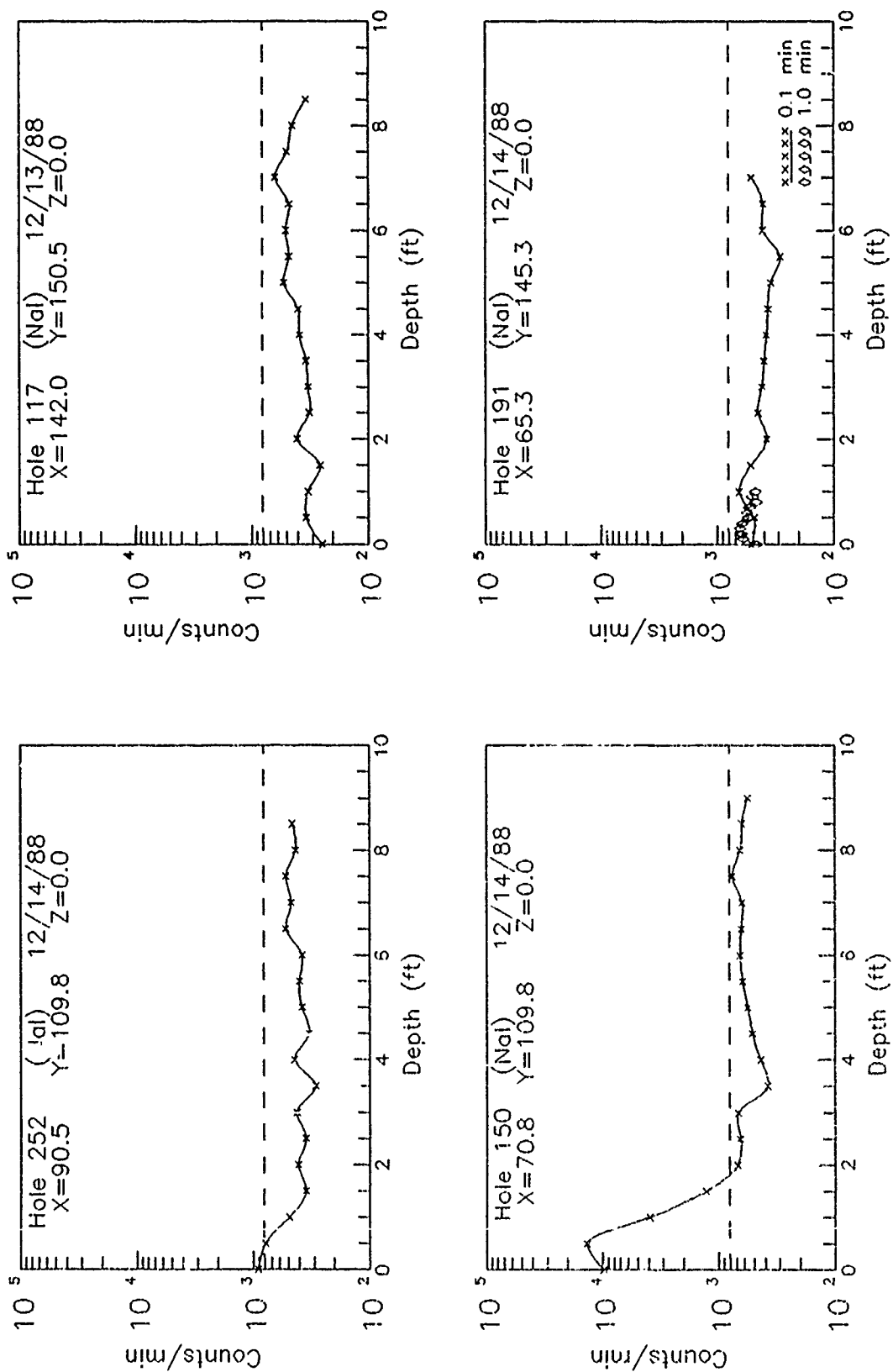


FIGURE 21 Results of Some Typical Subsurface Investigations (clockwise from upper left: front yard #107 duplex; sideyard area #107 duplex; #105 duplex front yard near Stratford Avenue; #105 duplex front yard near house)

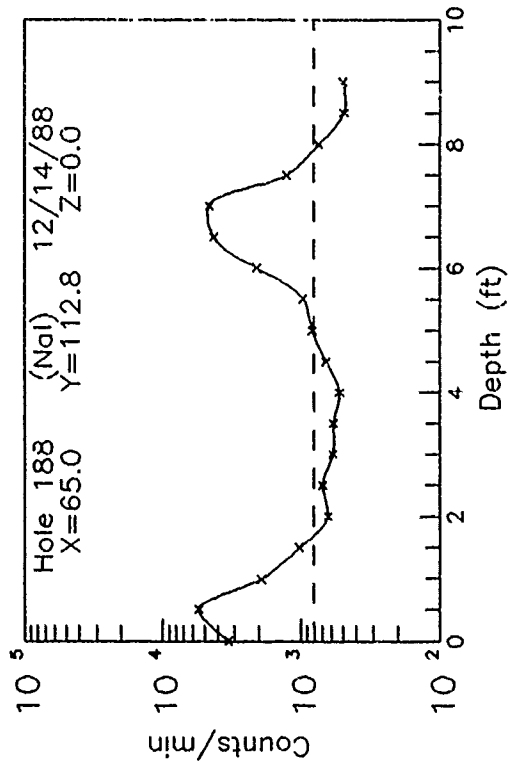
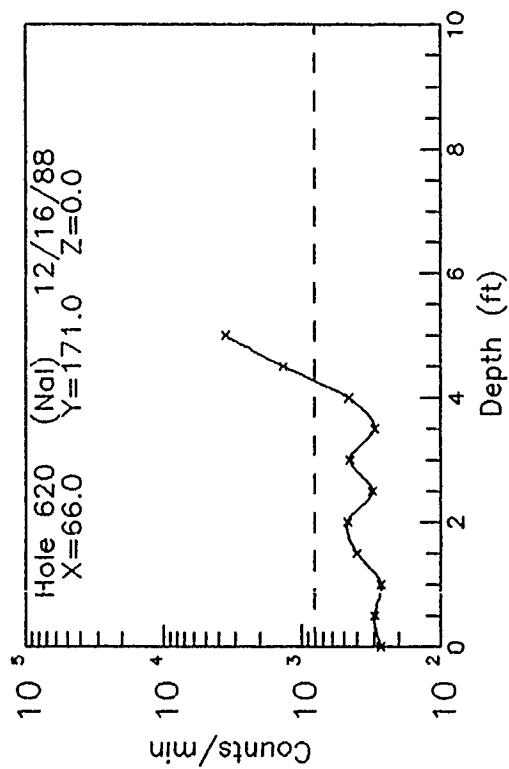
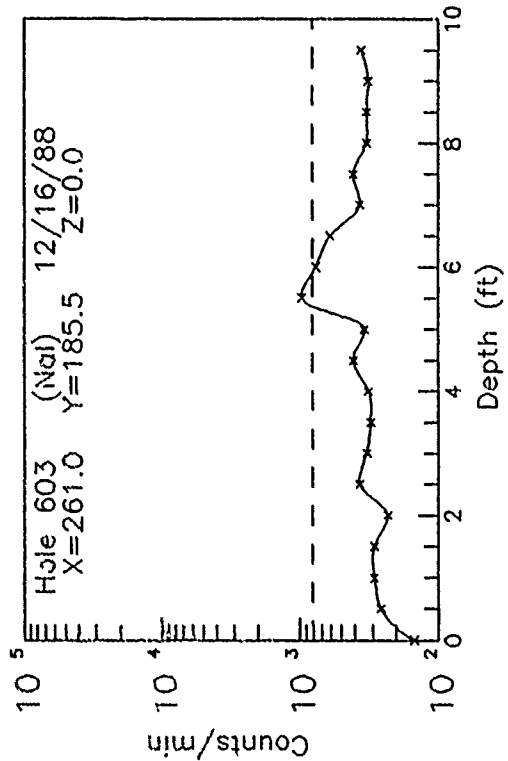
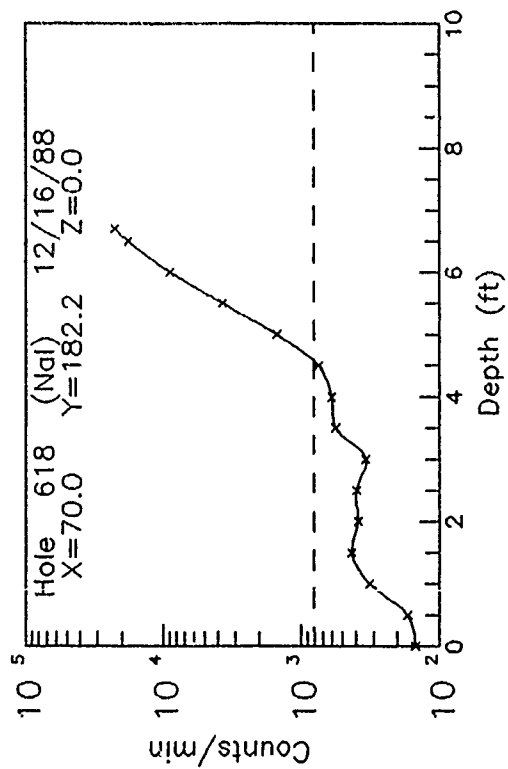


FIGURE 22 Subsurface Sewer Line Logging Data (clockwise from upper left): Stratford sewer line near junction with house lateral; Stratford sewer line ~10 ft from Union Junction; Sewer line lateral in front yard near house; sewer line lateral near junction with main Stratford sewer line

junction point with the duplex lateral. The upper right graph shows some contamination at the Stratford sewer line near the junction with Union Avenue. In both cases, a sharp rise in the measured count rate occurs beyond 4 ft below grade. The bottom two graphs refer to measurements made in close proximity to the sewer line lateral in the front yard of the duplex. Illustrated in the bottom right graph is some contamination measured near grade level and contamination measured in the sewer line lateral about 5 ft below grade. The detector was shielded to enable some discrimination between contamination at various depths to be obtained.

After excavation operations had exposed the sewer line (Fig. 23) direct measurements were made of the sewer line pipe and the surrounding soil. Virtually all of the sewer line junction points showed varying degrees of leakage and soil contamination. Veins of contaminated soil and granite were identified underneath the sewer line pipe. Soil and/or granite samples were collected from the sewer line trench and analyzed on a hyper-pure germanium spectrometry system to ensure residual activity concentrations were below the cleanup criterion. The results of all sample analyses are provided in



FIGURE 23 Removal of Stratford Avenue
Sewer Line

Appendix D, Tables D.7 and D.8. A photograph of the replacement sewer line is provided in Fig. 24.

5.4 Calculation of Contaminated Soil Volume

The count rate measurements for all of the logged holes were recorded and plotted on graph paper (count rate versus depth) so that a determination could be made as to the depth of contamination. In cases where contamination did exist, generally it was confined to the first few feet below grade. However, there were large areas of contamination, especially in the back yard of the duplex, where excavation of soil down to about 10 ft below grade was necessary.

After the contamination depths (maximum values) were established, a contour map was drawn revealing the vertical profile of soil exceeding the cleanup criterion. An electronic digital planimeter was used to determine the area corresponding to a specified



FIGURE 24 Stratford Avenue Sewer Line Replacement with French Drain

excavation depth. The product of these two values yields the volume element of soil to be removed. Summing over all elements on the property, the total volume of soil to be removed was estimated to be approximately $40,000 \text{ ft}^3 \pm 10,000 \text{ ft}^3$. A unit weight factor of 0.06 tonnes per ft^3 of soil was used by the USACOE personnel to estimate the total weight of contaminated soil for removal. The map in Fig. 25 shows the variation in the soil contamination profile over the site and the peripheral properties. White areas within the site boundaries in Fig. 25 represent areas excavated prior to the contaminated soil volume estimate. Determination of the volume of contamination onsite was necessarily an iterative process involving follow-up subsurface investigations, soil sampling and analysis, and knowledge gained during excavation activities. The Contractor was instrumental in supplying survey/sampling data which were used to guide the excavation and trigger re-evaluations. Figure 25 represents a composite of data from soil tube logging in the site test area, throughout the property, and on the peripheral properties after the final re-evaluation of the data.

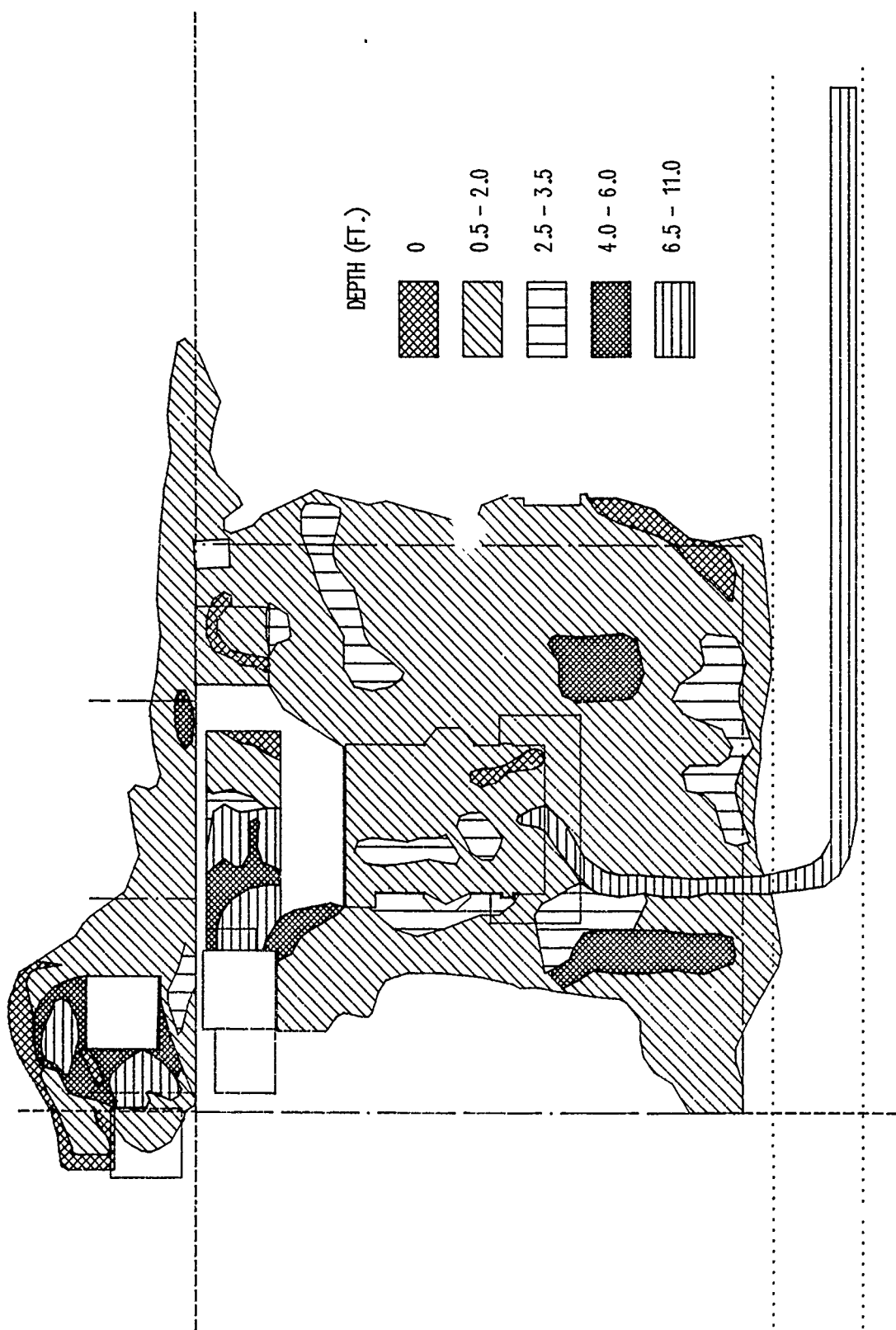


FIGURE 25 Predicted Soil Excavation Depths Based on Subsurface Investigations

6.0 RADIATION SURVEYS OF SITE DURING/AFTER REMEDIATION ACTIVITIES

The site was divided up into 10' by 10' grids before soil remediation activities and the ground surface surveyed for contamination with a PRM-5-3 survey meter and a PG-2 sodium iodide detector. The survey instrument was operated in the gross mode so that a wide range of gamma-ray energies could be detected. Since the sodium iodide crystal itself is quite thin (2 mm), the greatest sensitivity is to gamma-rays with energies less than about 200 keV. Survey measurements made near the ground surface are probably able to detect ^{226}Ra contamination down to a couple of feet below grade.

Each gridded area was surveyed with the PG-2 detector a few inches above grade level at a slow walking pace. Headphones were used to help the surveyor identify contaminated areas within a grid. Areas exhibiting count rates in excess of 1.5-2 times the instrument background level were sampled and the soil analyzed on the gamma spectrometry system to determine the actual ^{226}Ra soil concentration. Results from the subsurface investigation were used to identify deep pockets of offsite contamination near the garages which might otherwise be undetectable at ground surface. The entire site was surveyed with the PRM-5-3 meter and PG-2 detector by ANL to identify contaminated areas and to verify that remediated areas were completely within the cleanup criterion. The Contractor surveyed the site for excavation purposes. The actual remediation effort was guided by a Contractor technician constantly assessing the degree of soil contamination using portable survey equipment as the backhoe removed soil from the area. ANL staff also made independent survey measurements in conjunction with those made by the Contractor technician (Fig. 26). Areas of soil that were obviously contaminated were removed and disposed of as contaminated soil. After each layer of soil was removed, another survey was performed (Fig. 27) to determine whether additional remediation was necessary.

The response of PRM-5-3/PG-2 detector survey instrument was checked daily using an ^{241}Am source and a ^{235}U source in both the gross and pulse height analysis modes to verify that the instrument was performing satisfactorily. The results of the instrument quality control checks using the ^{235}U source with the instrument in the gross mode are listed in Table 7 for the period January-June 1989. Nominal instrument response to this check source is 250,000 cts/min.



FIGURE 26 Excavation of Contaminated Soil Identified with Survey Meter



FIGURE 27 Survey with PRM-5-3 during Soil Excavation

TABLE 7 Quality Control Log for the PRM-5-3 Survey Instrument

Date	Instrument Serial No.	Instrument Response (cts/min × 1000)	Date	Instrument Serial No.	Instrument Response (cts/min × 1000)
1/4/89	3017	250	2/2/89	2985	240
	2985	190		3017	260
1/5/89	3017	275	2/7/89	3013	260
	2985	225	2/11/89	2985	280
1/6/89	3017	275	2/24/89	2985	280
	2985	225	2/25/89	2985	200
1/7/89	2985	260	2/27/89	2985	200
	3017	250	2/28/89	2985	200
1/9/89	2985	275	3/1/89	2985	200
	3017	250	3/2/89	2985	200
1/10/89	3017	260	3/7/89	2985	275
	2985	275		3013	275
	3017	260	3/8/89	2985	275
1/11/89	3017	260		3013	275
1/16/89	3017	260	3/9/89	2985	275
1/17/89	3017	260		3013	275
	2985	260	3/10/89	2985	275
1/18/89	3017	260		3013	275
	2985	270	3/11/89	2985	275
1/19/89	3017	260		3013	275
	2985	270	3/13/89	2985	275
1/20/89	2985	270		3013	275
	3017	260	3/14/89	2985	275
1/21/89	2985	260		3013	275
	3017	270	3/15/89	2985	275
1/23/89	2985	275		3013	270
	3017	250	3/16/89	2985	225
1/24/89	2985	275	3/17/89	2985	275
	3017	250		3013	250
1/25/89	2985	275	3/18/89	3013	250
	3017	250		2985	275
1/26/89	2985	275	3/20/89	3013	250
	3017	250		2985	275
1/27/89	2985	275	3/21/89	3013	275
	3017	270		2985	275
1/28/89	2985	250	3/22/89	3013	275
	3017	260		2985	300
1/30/89	2985	270	3/23/89	3013	275
	3017	250		2985	275
1/31/89	2985	240	3/28/89	2985	275
	3017	260		3013	275
2/1/89	2985	270	3/29/89	2985	275
	3017	250		3013	275

TABLE 7 (Cont'd)

Date	Instrument Serial No.	Instrument Response (cts/min × 1000)	Date	Instrument Serial No.	Instrument Response (cts/min × 1000)
3/30/89	2985	275	4/21/89	2985	175
	3013	275		3013	180
3/31/89	2985	245	4/22/89	3013	175
	3013	245		2985	200
4/1/89	2985	250	4/24/89	2985	170
	3013	250	4/25/89	2985	175
4/3/89	2985	200	4/26/89	2985	155
	3013	200	4/27/89	2985	175
4/4/89	2985	200	4/28/89	2985	175
	3013	200	4/28/89	3013	190
4/5/89	2985	200	5/1/89	2985	175
	3013	200		3013	175
4/6/89	3013	200	5/2/89	2985	175
	2985	200		3013	180
4/7/89	3013	200	5/3/89	2985	180
	2985	300		3013	180
4/10/89	3013	250	5/4/89	2985	250
	2985	300		3013	280
4/11/89	3013	250	5/8/89	3013	280
	2985	260	5/25/89	3013	300
4/12/89	3013	250	5/31/89	3013	200
	2985	250	6/14/89	3013	200
4/20/89	2985	170		2985	250
	3013	180			

Note: Instrument response check performed with a source of ^{235}U placed in contact with the PG-2 detector.

7.0 SOIL SAMPLING, PREPARATION, AND ANALYSIS

7.1 Site Gridding

The entire site, including the peripheral properties, was subdivided into over 300 10-ft by 10-ft grids. A map depicting all of the site grids is provided in Fig. 28. The gray shaded region of the map represents the 105/107 Stratford Avenue property boundary. Three Stewart Avenue properties which had varying degrees of soil remediation are shown along the north property boundary. A property at 60 Union Avenue abuts with the northeast corner of the 105/107 property. The south and west side of the property is bordered by residences at 115 Stratford and 114 Stewart, respectively. This map also shows the grid locations for removal of the Stratford Avenue sewer line, including the two lateral lines from the 105/107 property. The sewer line is not oriented along the street centerline as shown by the grid blocks. Near the northwest corner of the 105/107 property, 2-ft south of the north boundary and on the west property boundary is the location corresponding to the site reference coordinate (0, 0). Provided in Fig. 29 is a topographical map illustrating the degree of excavation which took place during the remediation activities.

7.2 Soil Sampling

Each grid was surveyed by ANL using a PRM-5-3 survey meter connected to a 5 cm x 2 mm sodium iodide detector (Eberline PG-2). Locations within a grid where contamination was identified by either the Contractor or ANL were remediated; that is, the contaminated soil was removed. After all identified contamination was removed, a systematic sampling method was initiated to cover the entire 24,000 ft² area as a final verification of the property. A soil sample was obtained from within each gridded area. Generally, only the top few centimeters of soil were collected at 8-10 different sampling locations within each grid. Sampling tools were wiped clean to avoid cross-contamination. The entire grid sample, usually a few thousand grams, was placed in a plastic bag, mixed for uniformity, split with the site Contractor, assigned a grid location identification number, and sent to the onsite ANL mobile laboratory for sample preparation and analysis. An example of the degree of soil excavation which took place during the site remediation is shown in Fig. 30.

7.3 Sample Preparation and Analyses Conducted at the Mobile Laboratory Onsite

Each incoming sample was logged in a sample log book with respect to grid location, date of sample collection and sample number. Some of the wet samples were allowed to air dry before sample packing. In some extreme cases, a microwave oven was used to dry the very wet soil samples to a moisture content by weight of between 5-20%. Soil samples were prepared for analysis at the mobile laboratory without any special processing (e.g., no grinding, sieving). Stones and root parts were, however, removed from the soil sample. Each sample was firmly packed in a 500 mL plastic Marinelli beaker, labeled with an identification number, sealed, and weighed prior to

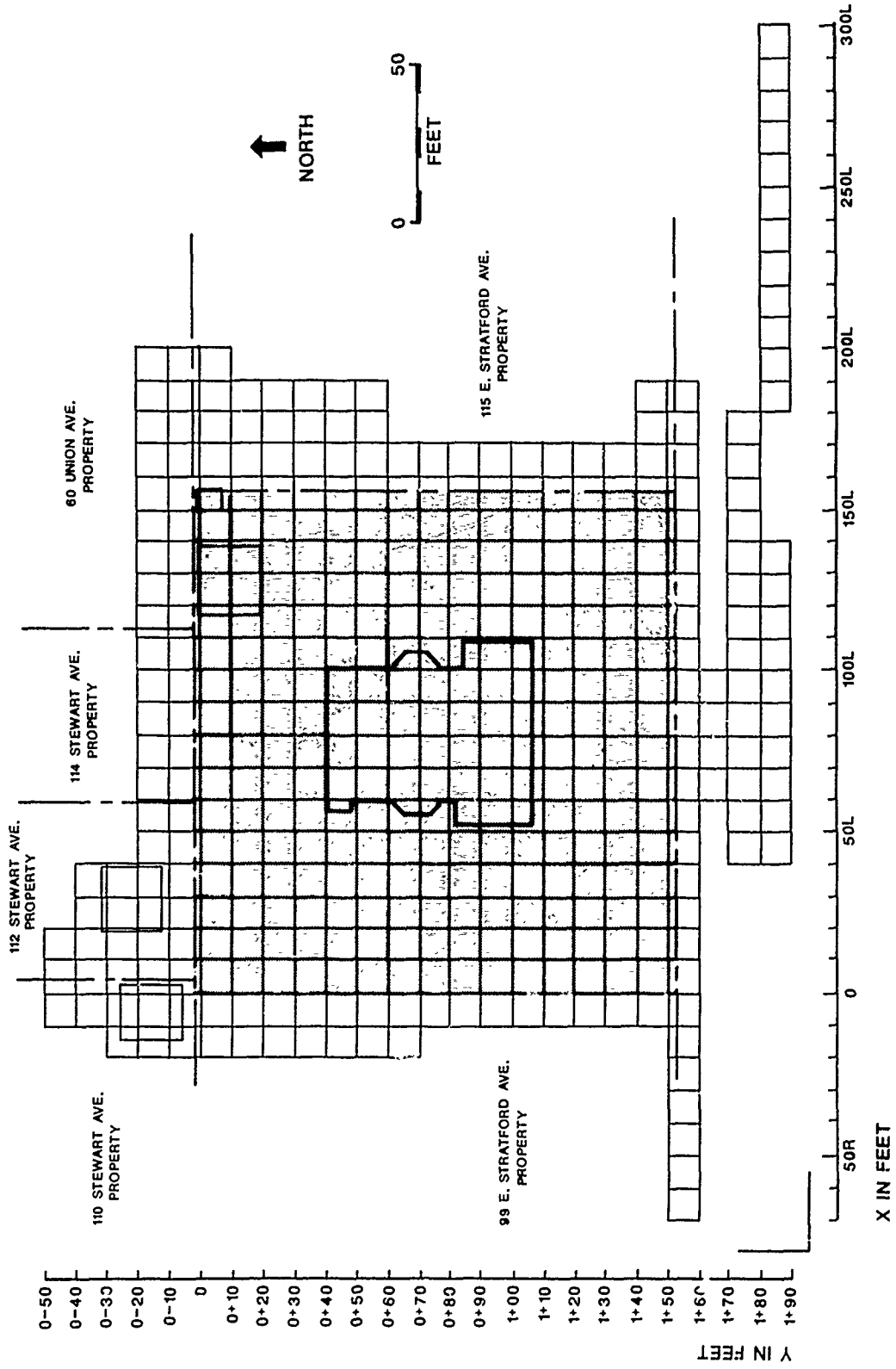


FIGURE 28 Sample Grid Identification Map

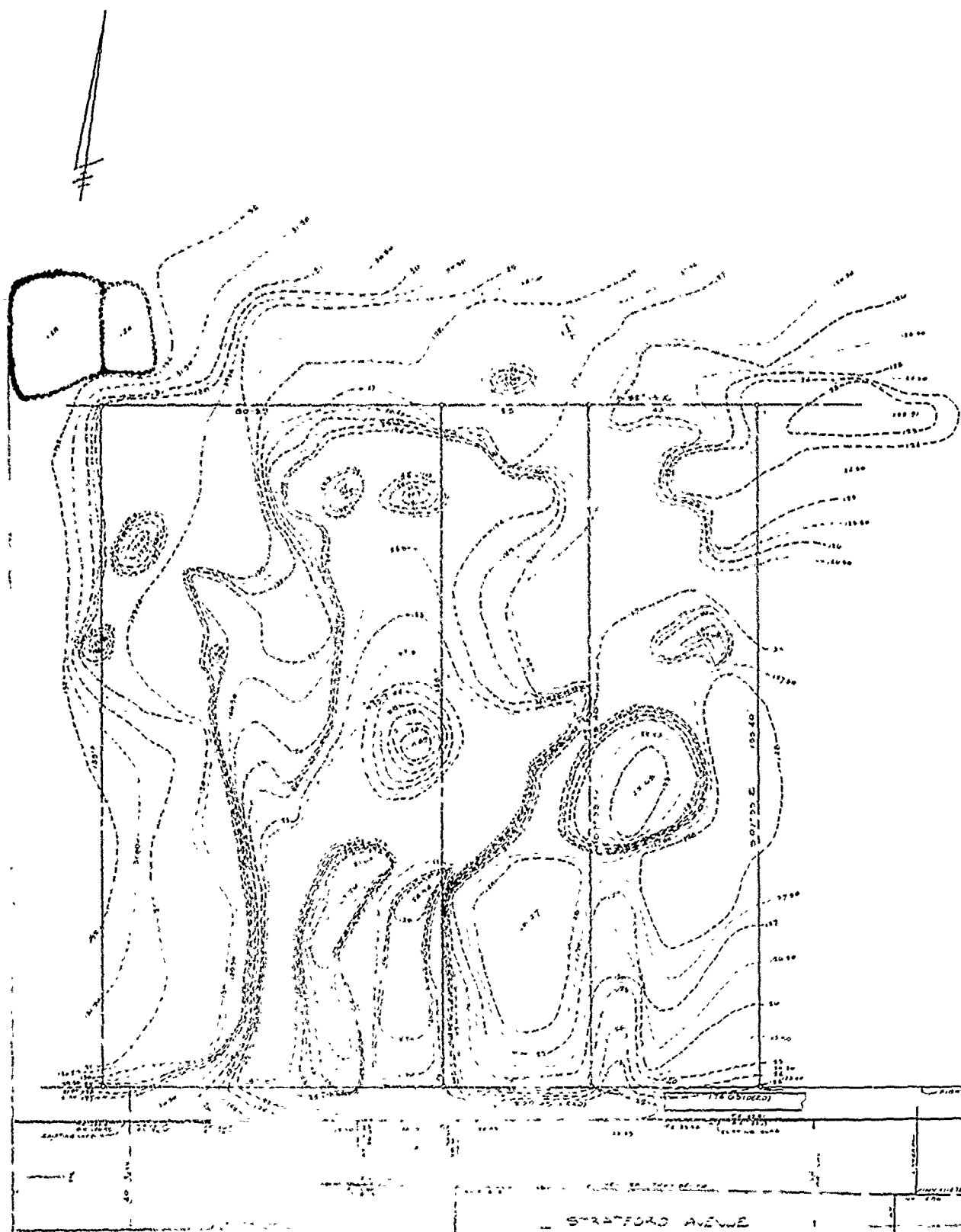


FIGURE 29 Contour Map of the Actual Soil Excavated Onsite



FIGURE 30 View of the Site After Most of the Soil Excavation Was Completed

analysis (Fig. 31). After recording the sample identification number and the sample mass in the sample log book, the sample was placed on a hyper-pure germanium (HPGe) detector and counted for 20 minutes.

Gamma-ray spectrometry was used to identify and quantify the amount of ^{226}Ra in soil using the unique gamma rays which are emitted by ^{226}Ra and its daughter products. Radium-226 emits a gamma-ray directly (186 keV) but with a very low intensity; for every one hundred ^{226}Ra atoms disintegrating only three 186.2 keV gamma-rays are emitted. Alternatively, two different ^{226}Ra daughter products can be analyzed to infer the quantity of ^{226}Ra present in the sample. The two daughter products of primary interest are ^{214}Pb with a 352 keV gamma-ray (intensity 37%) and ^{214}Bi with a 509 keV gamma ray (intensity 46%). There are a few distinct advantages to using either/both of these gamma-rays to quantify the radium content in the sample: (1) their energies are well-above the low energy portion of the spectrum where the background continuum rises; (2) their intensities are much improved versus the 3% value



FIGURE 31 Weighing of Soil Samples in Marinelli Beakers in Preparation for Analysis

associated with the 186 keV gamma-ray; and (3) self-absorption of intermediate energy gamma-rays in the Marinelli sample is less crucial than that for lower energy gamma-rays. There is, however, one distinct drawback to using these daughter product gamma-rays during the initial sample analysis. Radon-222 is the immediate daughter formed by the decay of ^{226}Ra and, as a noble gas, may potentially escape the soil during sample taking and preparation. Since the daughter products depend on radon being present in the sample for their continual formation, the loss of this gas causes a disequilibrium or imbalance to occur. Using the daughter products immediately after sample taking to infer the ^{226}Ra content in the sample may produce significant underestimates. Therefore, the sample should be left to age to permit an equilibrium condition to be established between ^{226}Ra and its progeny. Waiting in excess of 20 days for samples to be analyzed and the results reported causes significant problems during a dynamic cleanup operation.

There are a couple of alternatives available in addressing the problem of daughter product disequilibrium in the sample. The simplest approach is to use the 186.2 keV gamma-ray of ^{226}Ra and not rely on the daughter products to infer the radium content of the sample. The availability of a high-resolution germanium spectrometer makes this measurement approach possible. There is, however, a complication since ^{235}U which is also found naturally in soil which emits a gamma-ray of 185.7 keV. If the interference produced by the ^{235}U gamma ray is ignored, it is estimated that for a ^{226}Ra concentration of 5 pCi/g in excess of a natural radium background level of 1.5 pCi/g an overestimate of about 20% will be observed. For example, if the actual concentration of ^{226}Ra in the soil sample is 5 pCi/g, the measured value of the radium

concentration will be closer to 6 pCi/g. For purposes of a cleanup operation, overestimates of 20% are probably tolerable from a practical point of view. In addition to the 185.7 keV gamma ray, ^{235}U also emits 144 keV and 163 keV gamma rays. However, their abundances are so low that it becomes impractical to use these additional ^{235}U gamma-rays for quantification of the ^{235}U content in soil samples for the selected counting time of 20 minutes. The second approach is to measure the two primary daughter products (^{214}Pb and ^{214}Bi) in the disturbed state and apply a correction factor to estimate their abundance after a 20-day in-growth period. This approach has the disadvantage of not knowing the actual state of disequilibrium of the sample to which the correction factor is applied. Soil samples with a high water content may not be as susceptible to radon being driven off as are extremely dry soil samples. Applying an appropriate correction factor to the data may not be as straightforward as it might initially appear.

After reviewing a number of alternatives, it was decided that using the ^{226}Ra gamma-ray (186 keV) directly to estimate the quantity of radium present in the sample would be the best approach. A series of tests were performed using a radium standard with a concentration of 3 pCi/g to determine the optimum counting period for the field samples given the time constraints associated with processing large numbers of samples. The shortest counting period which would enable identification and quantification of radium at 3 pCi/g concentration using the 186 keV gamma ray was determined to be about 20 minutes. All soil samples were analyzed for 20 minutes at the mobile laboratory. Most samples were re-analyzed at the mobile laboratory after a 20-day daughter product ingrowth period so that the radium activity in the sample based on the 186 keV gamma-ray could be compared with the radium activity based on analyzing the daughter products at equilibrium. These data have been compiled in Appendix D, Table D.9.

7.4 Sample Preparation and Analyses Conducted by the Analytical Chemistry Laboratory

After the follow-up analyses at the mobile laboratory were complete, approximately 10% of the verification soil samples were sent back to Argonne National Laboratory for independent analysis by the ANL Analytical Chemistry Laboratory (ACL). Samples were shipped to ACL in Marinelli beakers. An aliquot from each Marinelli beaker was taken and analyzed in a 4 ounce wide-mouth plastic bottle. An additional aliquot was taken from the Marinelli beaker and dried to determine the soil moisture content of the analyzed sample. All of the samples were counted for 8-10 hours using a germanium detector. The radium content in each sample analyzed was determined using the two major ^{226}Ra daughter products, ^{214}Pb and ^{214}Bi . Soil moisture content was determined for each sample so that the radium activity concentration was reported as a dry weight concentration in pCi/g. All of the re-analyses conducted by the ACL group should be treated as completely independent of those analyses made by ESH personnel. The ACL is in a separate division at ANL and was contracted by the ESH Division to provide soil sample analyses as a disinterested party to the project. These data have been compiled in Table 10.

7.5 Sample Preparation and Re-analyses Conducted at ANL by ESH Personnel

Most of the samples analyzed in the field were re-analyzed back at Argonne National Laboratory by ESH Personnel. The purpose of the re-analysis was to evaluate the effect of the moisture content on the initial analyses which were performed at the mobile laboratory. Soil was removed from each Marinelli beaker, dried at 110°C for two days in an oven, and re-packed in the Marinelli beaker. The soil was also weighed before and after drying so that the soil moisture content could be determined. The samples were then placed on a hyper-pure germanium detector and counted for 20 minutes. The data have been compiled in Appendix D.

7.6 Quality Control Protocol for Gamma-ray Spectrometry System

The gamma-ray spectrometry system onboard the ANL mobile laboratory was checked daily to ensure a continued level of satisfactory operation (Table 8). The daily quality control check involved analyzing a standard sample with a known quantity of uranium/radium uniformly dispersed through a silica matrix in a standard Marinelli beaker. The actual ^{226}Ra concentration of the standard was 2.96 pCi/g $\pm 4\%$. The measured radium concentration of the standard was compared directly with the concentration quoted for the standard. If the measured value of the standard differed by more than 20% of the quoted value for the standard, an investigation was undertaken to explain and resolve the discrepancy before any resumption of field sample analyses. The daily quality control check of the counting system was performed before the beginning of each daily sample counting cycle.

The radium standard was prepared from an NBL standard (New Brunswick Laboratory Sample No. 73) containing 1% uranium ore by weight as certified by Wittaker, Clark, and Daniels, Inc.

- 0.9983 grams of ore in 1110.45 grams of a silica matrix (#223 silica, 10 μm grain size)
- based on the ore containing 1% natural uranium by weight and an isotopic abundance of ^{238}U by weight of 0.992837, the quantity of ^{226}Ra present in the standard, under secular equilibrium conditions, is 3330 pCi $\pm 4\%$
- 370.22 grams of the batch standard was transferred to the Marinelli breaker. The ^{226}Ra concentration of the standard was 2.96 pCi/g ± 0.12 pCi/g
- Marinelli breaker was sealed after preparation of the standard on 1 August 1988

**TABLE 8 Quality Control Log for
Gamma Spectrometry System**

Q.C. Date	<u>Measured Reference Peaks</u>	
	<u>Radium concentrations, pCi/g</u>	
	^{214}Pb	^{214}Bi
8-31-88	2.69 \pm 0.38	2.91 \pm 0.51
9-19-88	2.06 \pm 0.38	3.19 \pm 0.55
10-12-88	2.69 \pm 0.07	3.39 \pm 0.09
10-18-88	2.86 \pm 0.28	3.24 \pm 0.43
10-20-88	2.74 \pm 0.29	3.13 \pm 0.39
11-08-88	2.10 \pm 0.27	3.08 \pm 0.40
11-21-88	2.69 \pm 0.07	3.09 \pm 0.11
11-22-88	2.69 \pm 0.23	2.93 \pm 0.33
11-29-88	1.99 \pm 0.28	2.64 \pm 0.41
12-01-88	2.70 \pm 0.21	2.45 \pm 0.29
12-02-88	2.48 \pm 0.21	3.43 \pm 0.28
12-03-88	2.56 \pm 0.21	3.25 \pm 0.29
12-11-88	2.36 \pm 0.21	2.68 \pm 0.28
12-13-88	2.95 \pm 0.34	3.20 \pm 0.37
12-14-88	2.37 \pm 0.21	3.10 \pm 0.29
12-15-88	2.42 \pm 0.22	3.10 \pm 0.29
12-19-88	2.17 \pm 0.20	3.46 \pm 0.30
01-04-89	2.71 \pm 0.21	3.44 \pm 0.28
01-07-89	2.76 \pm 0.21	3.28 \pm 0.31
01-10-89	2.70 \pm 0.21	2.92 \pm 0.28
01-13-89	2.91 \pm 0.21	2.88 \pm 0.28
01-22-89	2.41 \pm 0.22	3.66 \pm 0.31
01-25-89	2.42 \pm 0.20	3.10 \pm 0.29
01-28-89	2.55 \pm 0.23	2.73 \pm 0.28
01-31-89	2.83 \pm 0.21	2.67 \pm 0.27
02-01-89	2.63 \pm 0.21	3.86 \pm 0.30
02-03-89	2.68 \pm 0.22	3.36 \pm 0.29
02-10-89	2.70 \pm 0.22	3.30 \pm 0.28
02-14-89	2.63 \pm 0.20	4.00 \pm 0.28
02-17-89	2.51 \pm 0.19	3.23 \pm 0.26
02-23-89	2.29 \pm 0.20	2.90 \pm 0.27
02-27-89	2.33 \pm 0.19	3.10 \pm 0.26

TABLE 8 (Cont'd)

Q.C. Date	Measured Reference Peaks	
	Radium concentrations, pCi/g	
	^{214}Pb	^{214}Bi
03-01-89	2.02 ± 0.19	3.11 ± 0.27
03-08-89	2.61 ± 0.20	3.35 ± 0.27
03-11-89	2.45 ± 0.20	3.21 ± 0.28
03-15-89	2.44 ± 0.20	3.15 ± 0.26
03-22-89	2.52 ± 0.04	2.73 ± 0.05
03-27-89	2.01 ± 0.18	2.79 ± 0.22
03-29-89	2.69 ± 0.19	2.63 ± 0.22
03-30-89	2.46 ± 0.18	2.71 ± 0.20
04-01-89	2.39 ± 0.19	2.84 ± 0.24
04-04-89	2.43 ± 0.20	2.81 ± 0.22
04-07-89	2.68 ± 0.20	2.32 ± 0.21
04-10-89	2.55 ± 0.20	2.77 ± 0.22
04-13-89	2.49 ± 0.20	2.77 ± 0.24
04-14-89	2.53 ± 0.18	2.66 ± 0.21
04-17-89	2.54 ± 0.20	2.62 ± 0.20
04-18-89	2.97 ± 0.18	2.91 ± 0.24
04-20-89	2.23 ± 0.19	3.18 ± 0.22
04-24-89	2.68 ± 0.18	2.24 ± 0.22
04-27-89	2.48 ± 0.19	2.63 ± 0.22
05-01-89	2.41 ± 0.20	1.78 ± 0.21
05-03-89	2.75 ± 0.20	2.79 ± 0.24
05-06-89	2.29 ± 0.19	2.74 ± 0.22
05-09-89	2.57 ± 0.19	2.71 ± 0.22
05-10-89	1.95 ± 0.19	2.64 ± 0.22
05-11-89	2.37 ± 0.18	2.99 ± 0.22
05-12-89	2.82 ± 0.19	3.07 ± 0.21
05-16-89	2.46 ± 0.19	3.14 ± 0.22
05-17-89	2.44 ± 0.18	2.62 ± 0.21
05-18-89	2.36 ± 0.18	2.75 ± 0.23
05-19-89	3.27 ± 0.27	2.63 ± 0.35
05-20-89	2.48 ± 0.25	2.40 ± 0.31
05-22-89	2.30 ± 0.26	2.42 ± 0.31
05-23-89	1.55 ± 0.19	1.85 ± 0.24
05-24-89	2.14 ± 0.26	2.75 ± 0.31
05-25-89	3.06 ± 0.24	2.85 ± 0.31
05-26-89	2.17 ± 0.26	2.31 ± 0.32

TABLE 8 (Cont'd)

Q.C. Date	Measured Reference Peaks	
	Radium concentrations, pCi/g	
	^{214}Pb	^{214}Bi
06-07-89	2.63 \pm 0.38	2.65 \pm 0.50
06-08-89	2.38 \pm 0.25	2.89 \pm 0.31
06-09-89	2.52 \pm 0.26	2.11 \pm 0.32
06-12-89	2.05 \pm 0.26	2.25 \pm 0.32
06-13-89	2.19 \pm 0.25	2.50 \pm 0.30
06-14-89	2.07 \pm 0.28	1.93 \pm 0.31
06-15-89	2.94 \pm 0.24	2.15 \pm 0.30
06-16-89	2.44 \pm 0.26	2.20 \pm 0.31
06-27-89	2.69 \pm 0.21	2.64 \pm 0.22
06-29-89	3.11 \pm 0.21	2.91 \pm 0.24
06-30-89	2.76 \pm 0.21	2.62 \pm 0.24
07-12-89	2.59 \pm 0.22	2.33 \pm 0.22
07-17-89	2.88 \pm 0.22	2.44 \pm 0.23
07-18-89	2.82 \pm 0.22	2.65 \pm 0.23
07-19-89	2.97 \pm 0.22	2.56 \pm 0.22
07-20-89	2.99 \pm 0.23	2.69 \pm 0.24
07-21-89	3.20 \pm 0.22	2.68 \pm 0.22
07-25-89	2.88 \pm 0.23	3.08 \pm 0.23
07-26-89	2.80 \pm 0.22	2.65 \pm 0.22
08-07-89	3.22 \pm 0.21	2.31 \pm 0.23
08-08-89	3.00 \pm 0.22	2.53 \pm 0.23
08-09-89	2.92 \pm 0.23	2.70 \pm 0.24
08-10-89	2.89 \pm 0.22	2.50 \pm 0.24
08-11-89	2.78 \pm 0.24	2.80 \pm 0.23
08-14-89	3.27 \pm 0.22	2.70 \pm 0.24
08-17-89	3.00 \pm 0.22	2.82 \pm 0.23
08-18-89	2.51 \pm 0.22	2.32 \pm 0.21
08-22-89	3.09 \pm 0.23	3.05 \pm 0.24
08-23-89	2.71 \pm 0.21	3.04 \pm 0.24
08-24-89	2.68 \pm 0.21	2.85 \pm 0.23
08-25-89	2.84 \pm 0.22	2.91 \pm 0.23
08-28-89	3.69 \pm 0.24	3.75 \pm 0.26
08-29-89	2.84 \pm 0.22	2.83 \pm 0.23
08-30-89	3.04 \pm 0.22	2.61 \pm 0.23
08-31-89	2.95 \pm 0.25	3.16 \pm 0.24
09-01-89	2.78 \pm 0.23	3.00 \pm 0.24
09-05-89	2.87 \pm 0.21	2.89 \pm 0.24
09-06-89	3.46 \pm 0.25	3.88 \pm 0.26

TABLE 8 (Cont'd)

Q.C. Date	<u>Measured Reference Peaks</u>	
	<u>Radium concentrations,</u>	
	<u>pCi/g</u>	
	^{214}Pb	^{214}Bi
09-07-89	2.92 ± 0.22	2.62 ± 0.22
09-12-89	2.58 ± 0.23	2.49 ± 0.23
09-15-89	2.66 ± 0.22	2.79 ± 0.24
09-18-89	2.07 ± 0.22	2.56 ± 0.23
09-21-89	2.78 ± 0.22	2.96 ± 0.24
09-22-89	2.91 ± 0.21	2.65 ± 0.22
09-25-89	2.35 ± 0.21	2.07 ± 0.26
09-26-89	2.01 ± 0.22	2.23 ± 0.23
09-27-89	2.12 ± 0.21	2.25 ± 0.21
10-18-89	2.70 ± 0.22	2.87 ± 0.23
10-19-89	2.97 ± 0.22	2.82 ± 0.23
10-20-89	2.51 ± 0.23	2.76 ± 0.23
10-23-89	2.81 ± 0.22	2.54 ± 0.21
10-25-89	3.12 ± 0.23	2.77 ± 0.22
10-27-78	2.91 ± 0.21	2.70 ± 0.24
10-30-89	2.66 ± 0.21	3.01 ± 0.21
11-03-89	2.47 ± 0.21	2.57 ± 0.25
12-01-89	3.00 ± 0.21	2.65 ± 0.22
12-04-89	3.04 ± 0.22	2.74 ± 0.24

8.0 RESULTS OF SAMPLE ANALYSES

8.1 Verification Soil Sample Analyses

1. The measured ^{226}Ra soil concentration in all of the final verification samples analyzed was less than the clean-up criterion of 5 pCi/g above the natural background level of 1.5 pCi/g. The quantity of ^{226}Ra in each sample was determined from analysis of the ^{214}Bi 609 keV gamma-ray after a minimum of 20 days for daughter product ingrowth in the sealed Marinelli beaker. The ^{226}Ra concentrations reported for all soil verification analyses does not include any soil moisture correction to a dry weight basis. These data are contained in Appendix E in the column labeled "Field."
2. Virtually all of the soil samples were dried upon receipt at Argonne National Laboratory to determine the moisture content of the samples. The average moisture content in the soil samples analyzed was estimated to be 5% by weight. Although it makes sense to report activity concentrations on a dry weight basis, there is no guidance on this point in the regulations.
3. Determination of the ^{226}Ra concentrations in soil using the daughter products ^{214}Pb and ^{214}Bi without allowing for equilibrium conditions to be established (e.g., 20 day build-up) will tend to result in an underestimation of the actual ^{226}Ra concentration of between 30%-80%.
4. By aging the samples for a minimum of 20 days to allow for daughter product ingrowth to occur and applying soil moisture corrections, the ^{226}Ra concentration determined from analysis of ^{214}Pb and ^{214}Bi gamma-rays was found to be within 12% of the original estimate (based on using the 186 keV gamma ray). The data is shown in Appendix D, Table D.9.
5. In order to evaluate subtle differences in the soil sample analyses, the data were stratified into two groups, those samples ≥ 3 pCi/g and those < 3 pCi/g.
 - Soil ^{226}Ra concentrations ≥ 3 pCi/g -- A comparison was made between the measured soil concentrations using the 186 keV gamma-ray shortly after sample taking, after a 20 day waiting period, and after a re-analysis post sample drying. The results show very good reproducibility in the measured ^{226}Ra concentration using the 186 keV gamma-ray irrespective of the time post sample preparation in the Marinelli beaker. Since there is no daughter product

ingrowth to be concerned with in this case, the measurements should be nearly identical excepting for natural statistical variation.

- Soil concentrations < 3 pCi/g -- The reproducibility in the measured ^{226}Ra concentration using the 186 keV gamma-ray at various times after sample preparation is subject to significant fluctuation. The wide measurement variability is thought to be related to the low concentrations of ^{226}Ra and the small population size of samples analyzed. Based on the data reviewed, there is better precision at the higher ^{226}Ra concentrations. Generally, less precision is tolerable at low concentrations since these levels are far below the clean-up criterion.
6. Based on the results provided in 4 and 5 above, the 186 keV gamma-ray from ^{226}Ra was found to be satisfactory in determining the ^{226}Ra concentration in soil. Although the measurement is likely to overestimate the actual ^{226}Ra concentration of the sample, the advantage of expediency in the sample analysis outweighs overestimates of up to 12%.
 7. The distribution of ^{226}Ra concentrations in the aged verification soil sample analyses conducted by ANL personnel at the mobile laboratory is illustrated in Fig. 32 and the data tabulated in Appendix E. The ^{226}Ra concentrations in the soil samples is lognormally distributed with a median value of 1.8 pCi/g and an associated geometric standard deviation of 1.6 pCi/g. In a number of cases, the ^{226}Ra concentration from a particular sampling grid is less than the quoted ^{226}Ra background value of 1.5 pCi/g. This is interpreted to reflect the natural variation of ^{226}Ra in soil and the associated uncertainties in measuring low levels of radioactivity.

8.2 Results of Alpha Spectrometry and Uranium Fluorometric Analyses Performed by the Analytical Chemistry Laboratory (ACL)

Shown in Table 9 is a listing of various samples including soil, brick, mortar, tile, sludge, and ash which were analyzed by the Argonne Analytical Chemistry Laboratory using standard alpha spectrometry and uranium fluorometric techniques. These measurements were performed to determine whether other contaminants in addition to ^{226}Ra existed on the site. The radionuclides of interest included ^{230}Th , ^{231}Pa , ^{227}Ac , and uranium. Based on the data in Table 9, a decision was made that the 5 pCi/g criterion need apply only to ^{226}Ra .

Th-230 is the immediate parent to ^{226}Ra in the ^{238}U decay chain. Pa-231 and ^{227}Ac are daughter products in the ^{235}U decay chain. Uranium fluorometric analyses

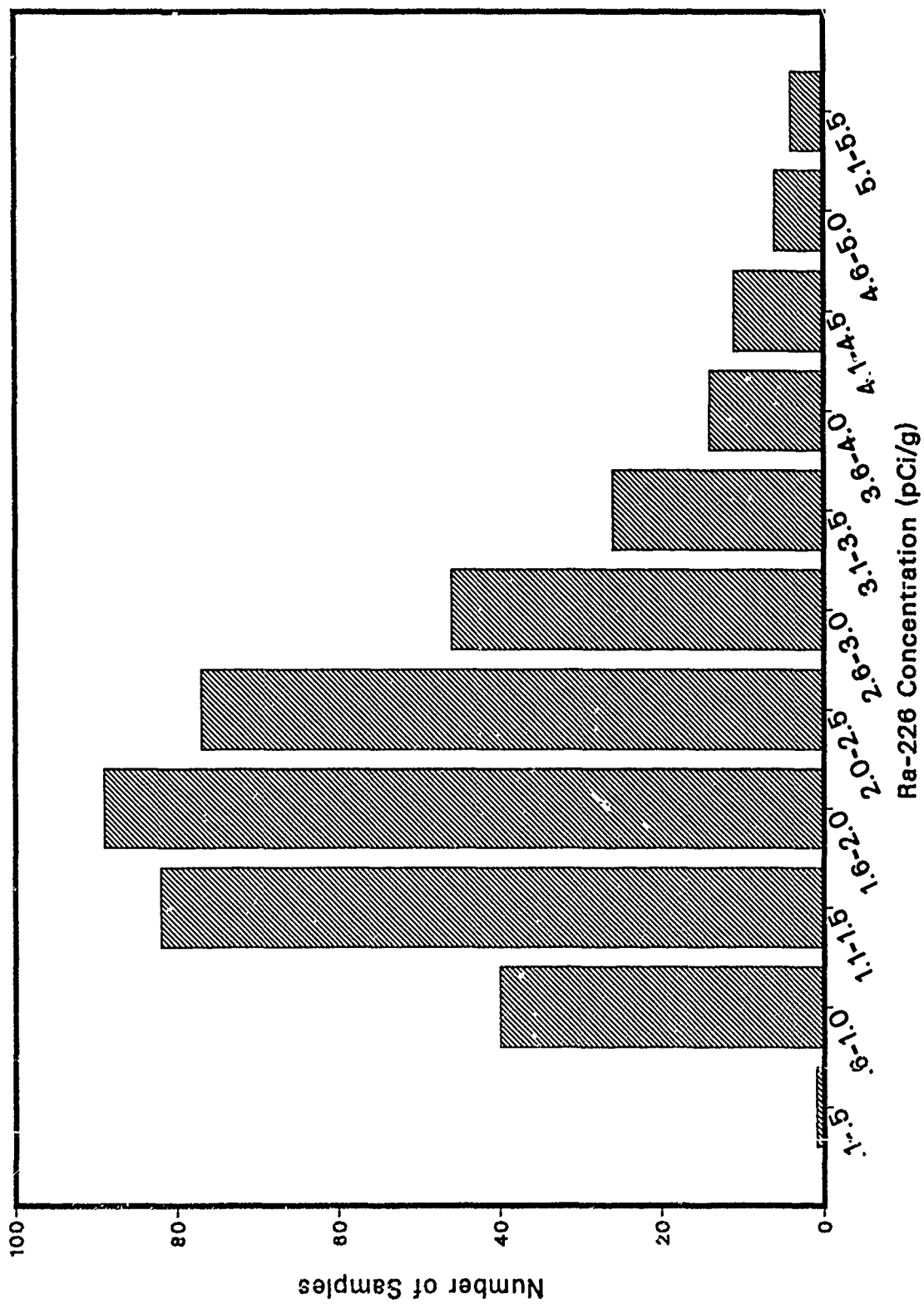


FIGURE 32 Distribution of ^{226}Ra Concentrations in Soil from the Results of the Final Verification Sample Analyses

TABLE 9 Results of Alpha Spectrometry and Uranium Fluorometric Analyses Performed on Various Types of Samples

Sample No.	Sample Location	Z Wt	Alpha Spectrometric pCi/g \pm σ			U Fluorometric Total Uranium	
			--Th 230--	--Ac 227--	--Pa 231--	--ug/g \pm σ --	--pCi/g \pm σ --
Verification Soil Samples							
*22-S-652	5L 0-35	94.3	0.62 \pm 0.04	0.23 \pm 0.02	NA	3.1 \pm 0.3	2.1 \pm 0.2
*22-S-645	35L 0-15	91.9	0.85 \pm 0.06	0.42 \pm 0.05	NA	2.4 \pm 0.2	1.6 \pm 0.2
*22-S-762	145L 0-15	79.9	0.90 \pm 0.04	0.16 \pm 0.03	NA	2.4 \pm 0.2	1.6 \pm 0.2
*22-S-749	65L 0-05	82.7	1.01 \pm 0.08	0.47 \pm 0.06	NA	2.8 \pm 0.3	1.9 \pm 0.2
*22-S-742	75L 0-05	80.0	1.21 \pm 0.09	0.37 \pm 0.05	NA	3.2 \pm 0.3	2.2 \pm 0.2
*22-S-728	105L 0-05	82.6	1.54 \pm 0.12	BDL	NA	4.0 \pm 0.4	2.7 \pm 0.3
*22-S-815	5L 0+05	83.3	1.21 \pm 0.10	0.27 \pm 0.09	NA	3.0 \pm 0.3	2.0 \pm 0.2
*22-S-527	35L 0+15	88.4	1.30 \pm 0.05	0.16 \pm 0.02	NA	NA	NA
*22-S-778	65L 0+15	89.8	1.48 \pm 0.11	0.52 \pm 0.08	NA	3.5 \pm 0.4	2.4 \pm 0.2
*22-S-391	105L 0+15	90.4	1.36 \pm 0.09	0.31 \pm 0.04	NA	NA	NA
*22-S-858	5R 0+25	88.8	1.13 \pm 0.06	0.20 \pm 0.03	NA	2.8 \pm 0.3	1.9 \pm 0.2
*22-S-574	5L 0+25	91.0	1.35 \pm 0.09	0.32 \pm 0.04	NA	2.8 \pm 0.3	1.9 \pm 0.2
*22-S-871	165L 0+25	78.9	0.93 \pm 0.07	0.33 \pm 0.05	NA	3.3 \pm 0.3	2.3 \pm 0.2
*22-S-915	5R 0+35	75.9	1.19 \pm 0.10	0.39 \pm 0.06	NA	2.2 \pm 0.2	1.5 \pm 0.2
*22-S-859	5R 0+35	87.1	1.05 \pm 0.07	0.15 \pm 0.03	NA	2.5 \pm 0.3	1.7 \pm 0.2
*22-S-541	85L 0+35	89.6	1.18 \pm 0.05	0.20 \pm 0.02	NA	3.2 \pm 0.3	2.2 \pm 0.2
*22-S-894	175L 0+55	74.8	0.99 \pm 0.08	BDL	NA	2.4 \pm 0.2	1.6 \pm 0.2
*22-S-584	15L 0+65	90.8	1.01 \pm 0.05	0.33 \pm 0.04	NA	2.1 \pm 0.2	1.4 \pm 0.1
*22-S-476	75L 0+65	87.7	1.03 \pm 0.09	0.64 \pm 0.08	NA	NA	NA
*22-S-378	135L 0+65	83.0	1.50 \pm 0.12	0.93 \pm 0.12	NA	NA	NA
*22-S-370	145L 0+65	77.9	1.49 \pm 0.07	0.67 \pm 0.06	NA	NA	NA
*22-S-875	155L 0+65	86.4	0.91 \pm 0.05	0.29 \pm 0.03	NA	2.4 \pm 0.2	1.6 \pm 0.2
*22-S-863	5R 0+75	76.7	1.19 \pm 0.07	BDL	NA	2.3 \pm 0.2	1.6 \pm 0.2
*22-S-495	75L 0+75	88.0	0.95 \pm 0.04	0.54 \pm 0.04	NA	NA	NA
*22-S-694	135L 0+75	87.5	1.05 \pm 0.06	0.19 \pm 0.03	NA	3.8 \pm 0.4	2.6 \pm 0.3
*22-S-906	5R 0+95	75.9	1.11 \pm 0.06	0.20 \pm 0.03	NA	2.9 \pm 0.3	2.0 \pm 0.2
*22-S-822	5L 0+95	74.5	1.02 \pm 0.08	0.19 \pm 0.03	NA	2.2 \pm 0.2	1.5 \pm 0.2
*22-S-480	85L 0+95	88.6	1.17 \pm 0.07	0.53 \pm 0.07	NA	NA	NA
*22-S-907	5R 1+05	76.3	1.01 \pm 0.05	0.11 \pm 0.02	NA	2.6 \pm 0.3	1.8 \pm 0.2
*22-S-805	15L 1+05	81.5	1.03 \pm 0.06	0.20 \pm 0.03	NA	2.6 \pm 0.3	1.8 \pm 0.2
*22-S-879	155L 1+05	87.1	0.87 \pm 0.07	0.11 \pm 0.03	NA	2.4 \pm 0.2	1.6 \pm 0.2
*22-S-922	165R 1+05	78.9	0.92 \pm 0.05	0.15 \pm 0.03	NA	3.0 \pm 0.3	2.0 \pm 0.2

TABLE 9 (Cont'd)

Sample No.	Sample Location	% Wt	Alpha Spectrometric				U Fluorometric	
			--Th 230--	--AC 227--	--E 231--	--ug/g ± σ--	--ug/g ± σ--	Total Uranium
*22-S-908	SR 1+15	75.9	0.93±0.06	0.20±0.04	NA	2.8±0.3	1.9±0.2	
*22-S-679	15L 1+15	83.1	0.92±0.04	0.26±0.03	NA	2.2±0.2	1.5±0.2	
*22-S-796	35L 1+15	82.6	0.86±0.07	0.17±0.04	NA	2.3±0.2	1.6±0.2	
*22-S-708	55L 1+25	92.2	1.19±0.08	0.39±0.05	NA	3.2±0.3	2.2±0.2	
*22-S-721	125L 1+25	90.4	0.91±0.05	0.08±0.02	NA	2.7±0.3	1.8±0.2	
*22-S-911	SR 1+45	78.2	0.83±0.05	0.06±0.02	NA	2.8±0.3	1.9±0.2	
*22-S-790	15L 1+45	80.6	0.91±0.06	0.29±0.05	NA	2.5±0.3	1.7±0.2	
*22-S-699	145L 1+45	77.0	0.77±0.06	0.11±0.03	NA	2.1±0.2	1.4±0.1	
*22-S-675	165L 1+55	86.3	0.86±0.06	0.31±0.04	NA	3.0±0.3	2.0±0.2	
*22-S-839	65L 1+65	91.0	0.84±0.07	0.51±0.07	NA	2.9±0.3	2.0±0.2	
*22-S-519	55L 1+75	91.7	1.03±0.09	0.25±0.04	NA	2.9±0.3	2.0±0.2	
*22-S-557	75L 1+75	89.0	1.16±0.05	0.15±0.02	NA	0.4±0.0	0.3±0.0	
*22-S-590	135L 1+75	84.3	1.17±0.05	0.33±0.03	NA	5.2±0.5	3.6±0.4	
*22-S-610	255L 1+85	90.6	1.00±0.05	0.33±0.04	NA	3.5±0.4	2.4±0.2	
*22-S-634	75L 1+85	82.1	0.80±0.06	0.26±0.04	NA	2.5±0.3	1.7±0.2	
Ave		84.4	1.06	0.30		2.8	1.9	
Std dev		5.7	0.20	0.17		0.7	0.5	
Max		94.3	1.54	0.93		5.2	3.6	
Min		74.5	0.62	0.06		0.4	0.3	
No of Samples		47	47	44		40	40	
Miscellaneous Soil Samples								
*22-S-002	65L 1+05	72.2	14.53±0.76	0.74±0.05	0.11±0.01	3.2±0.3	2.2±0.2	
*22-S-003	75L 0+05	76.7	39.70±1.88	1.14±0.06	0.16±0.00	2.6±0.3	1.8±0.2	
*22-S-009	65L 0+35 4"	83.1	28.17±1.51	1.28±0.09	NA	NA	NA	
*22-S-009	65L 0+35 4"	83.1	28.17±1.51	1.28±0.09	NA	NA	NA	
*22-S-010	75L 0+05 4"	80.3	7.52±0.50	1.00±0.08	NA	NA	NA	
*22-S-011	55L 0+15 4"	85.8	40.19±1.52	1.72±0.08	NA	NA	NA	
*22-S-012	55L 0+15 8"	86.4	20.05±1.48	1.18±0.10	0.17±0.01	NA	NA	
*22-S-033	94L 0+13 1"	81.1	NA	NA	NA	NA	NA	
*22-S-033	94L 0+13 1"	81.1	NA	NA	NA	NA	NA	
*22-S-036	84L 0+23 17"	81.3	NA	NA	NA	NA	NA	
*22-S-036	84L 0+23 17"	81.3	NA	NA	NA	NA	NA	
*22-S-039	84L 0+23 20"	84.1	NA	NA	NA	NA	NA	
*22-S-039	84L 0+23 20"	84.1	NA	NA	NA	NA	NA	

TABLE 5 (Cont'd)

Sample No.	Sample Location	Zt	Alpha Spectrometric pci/g \pm σ			U Fluorometric Total Uranium	
			--Th 230--	--Ac 227--	--Pa 231--	--ug/g \pm σ --	--pci/g \pm σ --
*22-S-064	5L 0+15	85.7	1.72 \pm 0.08	1.15 \pm 0.06	0.06 \pm 0.01	NA	NA
*22-S-065	5L 0+05	84.1	1.40 \pm 0.19	0.54 \pm 0.09	0.06 \pm 0.01	NA	NA
*22-S-067	15L 0+05	83.0	1.39 \pm 0.13	1.29 \pm 0.17	0.06 \pm 0.01	NA	NA
*22-S-068	15L 0+15	84.0	1.09 \pm 0.12	2.36 \pm 0.23	0.07 \pm 0.01	NA	NA
*22-S-074	25L 0+05	83.5	1.40 \pm 0.10	1.15 \pm 0.08	0.12 \pm 0.01	NA	NA
*22-S-075	25L 0+15	82.4	1.82 \pm 0.17	3.01 \pm 0.30	0.06 \pm 0.01	NA	NA
*22-S-077	5L 0+25	84.2	1.00 \pm 0.08	0.11 \pm 0.02	NA	NA	NA
*22-S-078	15L 0+25	84.6	0.87 \pm 0.07	0.11 \pm 0.03	NA	NA	NA
*22-S-080	15L 0+45	75.3	6.77 \pm 0.56	0.32 \pm 0.06	NA	2.4 \pm 0.2	1.7 \pm 0.2
*22-S-082	5L 0+35	85.7	1.10 \pm 0.08	0.11 \pm 0.03	NA	NA	NA
*22-S-160	15L 1+15	77.4	1.49 \pm 0.17	1.47 \pm 0.22	NA	NA	NA
*22-S-160	15L 1+15	77.4	1.49 \pm 0.17	1.47 \pm 0.22	NA	2.4 \pm 0.2	1.7 \pm 0.2
22-S-189	Hole 191 Reg 83	74.6	NA	NA	NA	NA	NA
22-S-190	Hole 191 Reg 83	80.5	NA	NA	NA	NA	NA
*22-S-215	25L 0+55	87.0	2.86 \pm 0.28	3.08 \pm 0.33	0.07 \pm 0.01	NA	NA
*22-S-228	5L 1+05	72.0	0.97 \pm 0.08	NA	0.06 \pm 0.01	2.5 \pm 0.3	1.7 \pm 0.2
*22-S-239	5L 1+45	73.5	1.26 \pm 0.07	0.50 \pm 0.04	0.06 \pm 0.01	2.8 \pm 0.3	1.9 \pm 0.2
22-S-298	Hole 347 Reg 104	89.9	5.26 \pm 0.39	NA	NA	21.5 \pm 2.2	14.7 \pm 1.5
*22-S-298	Hole 347 Reg 104	90.6	5.26 \pm 0.39	NA	NA	21.5 \pm 2.2	14.7 \pm 1.5
22-S-299	Hole 347 Reg 104	93.6	NA	NA	NA	NA	NA
22-S-300	Hole 347 Reg 104	88.5	5.55 \pm 0.46	NA	NA	36.0 \pm 3.6	24.6 \pm 2.5
*22-S-300	Hole 347 Reg 104	88.0	5.55 \pm 0.46	NA	NA	36.0 \pm 3.6	24.6 \pm 2.5
*22-S-300	Hole 347 Reg 104	88.0	5.55 \pm 0.46	NA	NA	36.0 \pm 3.6	24.6 \pm 2.5
22-S-301	Hole 347 Reg 104	93.5	NA	NA	NA	NA	NA
*22-S-437	275L 1+85	73.5	0.57 \pm 0.05	0.38 \pm 0.04	NA	NA	NA
*22-S-437	185L 1+85	75.1	0.76 \pm 0.03	0.29 \pm 0.03	NA	NA	NA
*22-S-504	155L 1+75	91.3	1.00 \pm 0.05	0.38 \pm 0.03	NA	NA	NA
*22-S-857	5R 0+15	81.4	0.90 \pm 0.06	0.13 \pm 0.02	NA	3.1 \pm 0.3	2.1 \pm 0.2
Ave		82.7	7.28	1.02	0.09	8.5	5.8
Std dev		5.6	11.46	0.85	0.04	11.3	7.7
Max		93.6	40.19	3.08	0.17	36.0	24.6
Min		72.0	0.57	0.11	0.06	2.4	1.7
No of Samples		41	26	23	12	9	9

TABLE 9 (Cont'd)

Sample No.	Sample Location	% Wt	Alpha Spectrometric pCi/g ± σ			U Fluorometric Total Uranium		
			--Th 230--	--AC 227--	--Pa 231--	--ug/g ± σ--	--uCi/g ± σ--	
Backfill and Top Soil								
*22-SB-069	backfill #1	91.1	0.37±0.02	NA	NA	NA	NA	
*22-SB-070	backfill #2	80.1	0.92±0.04	NA	NA	NA	NA	
*22-SB-071	backfill #3	93.5	0.21±0.01	NA	NA	NA	NA	
*22-SB-072	backfill #4	91.8	0.23±0.01	NA	NA	NA	NA	
*22-SB-072	backfill #4	91.8	0.23±0.01	NA	NA	NA	NA	
*22-SB-073	backfill #4	76.0	0.99±0.06	NA	NA	NA	NA	
*22-SB-076	backfill #5	93.1	0.08±0.01	NA	NA	NA	NA	
*22-SB-851	backfill #3	92.0	0.29±0.02	0.09±0.01	NA	1.3±0.1	0.9±0.1	
*22-SB-928	top soil	80.5	0.74±0.08	0.18±0.04	NA	2.5±0.3	1.7±0.2	
Ave		88.4	0.45	0.14		1.9	1.3	
Std dev		6.6	0.32	0.04		0.6	0.4	
Max		93.5	0.99	0.18		2.5	1.7	
Min		76.0	0.08	0.09		1.3	0.9	
No of Samples		7	9	2		2	2	
Miscellaneous Samples								
*22-Z-001	105 wood	NA	0.42±0.04	BDL	0.04±0.01	0.8±0.1	0.6±0.1	
*22-Z-007	105 brick	NA	1.02±0.05	1.59±0.08	NA	NA	NA	
*22-Z-008	105 insulation	NA	6.79±0.36	1.60±0.13	NA	NA	NA	
*22-Z-008	105 insulation	NA	6.79±0.36	1.60±0.13	NA	NA	NA	
*22-Z-015	105 chimney tile	96.4	1.55±0.22	1.25±0.42	0.09±0.01	NA	NA	
*22-Z-015	105 chimney tile	96.4	1.55±0.22	1.25±0.42	0.09±0.01	NA	NA	
*22-Z-017	107 chimney tile	99.2	0.28±0.06	BDL	NA	NA	NA	
*22-Z-017	107 chimney tile	99.2	0.28±0.06	BDL	0.05±0.01	NA	NA	
*22-Z-018	107 chimney brick	98.9	1.25±0.08	1.22±0.10	NA	NA	NA	
*22-Z-018	107 chimney brick	98.9	1.25±0.08	1.22±0.10	NA	NA	NA	
*22-Z-020	105 mortar	97.8	2.67±0.18	1.38±0.11	0.05±0.01	NA	NA	
*22-Z-021	107 chimney brick	99.2	1.10±0.04	0.99±0.04	NA	NA	NA	
*22-Z-021	107 chimney brick	99.2	1.10±0.04	0.99±0.04	NA	NA	NA	
*22-Z-022	107 chimney brick	98.4	NA	NA	NA	NA	NA	
*22-Z-028	sewer sludge	83.5	0.97±0.09	0.41±0.12	0.05±0.01	2.2±0.2	1.5±0.2	
*22-Z-028	sewer sludge	83.5	0.97±0.09	0.41±0.12	0.05±0.01	2.2±0.2	1.5±0.2	

TABLE 9 (Cont'd)

Sample No.	Sample Location	Z Wt	Alpha Spectrometric pCi/g \pm σ			U Fluorometric Total Uranium	
			--Th 230--	--Ac 227--	--Pa 231--	--ug/g \pm σ --	--pCi/g \pm σ --
*22-Z-054	concrete 105	94.3	0.98 \pm 0.04	1.33 \pm 0.06	0.06 \pm 0.01	NA	NA
*22-Z-066	concrete 105	93.7	1.02 \pm 0.06	0.30 \pm 0.04	NA	NA	NA
*22-Z-555	ash 15L 0-05	77.2	NA	NA	NA	4.1 \pm 0.4	2.8 \pm 0.3
*22-Z-555	ash 15L 0-05	77.2	NA	NA	NA	4.1 \pm 0.4	2.8 \pm 0.3
*22-Z-556	ash 15L 0-05	75.3	NA	NA	NA	5.1 \pm 0.5	3.5 \pm 0.3
*22-Z-558	ash 15L 0-05	75.8	NA	NA	NA	25.2 \pm 2.5	17.2 \pm 1.7
22-Z-625	glass 19L 0-40		NA	NA	NA	NA	NA
Ave		91.3	1.64	0.92	0.06	7.5	5.1
Std dev		9.2	1.73	0.59	0.02	9.0	6.1
Max		99.2	6.79	1.60	0.09	25.2	17.2
Min		75.3	0.28	0.00	0.04	0.8	0.6
No of Samples		18	11	11	6	5	5
Smears							
*22-Z-004	105 basement floor		2.18 \pm 0.21	0.82 \pm 0.18	1.05 \pm 0.10	NA	NA
*22-Z-016	105 kitchen sink		0.76 \pm 0.04	0.01 \pm 0.01	0.12 \pm 0.01	NA	NA

*Samples dried and analyzed by the ACL.
 uncertainty in the counting statistics.
 NA = Data Not Available.
 BDL = Below Detectable Level.

were performed to determine the total uranium ($^{238}\text{U} + ^{235}\text{U} + ^{234}\text{U}$) content of some samples. In a few cases, above background concentrations of Th-230 were associated with very high concentrations of ^{226}Ra . One possible explanation is that during the radium refinement processes which were conducted, trace impurities of ^{230}Th were discarded as waste along with some ^{226}Ra .

Uranium fluorometric analyses on two soil samples taken adjacent to soil tube #347 showed total uranium concentrations of 15 pCi/g and 25 pCi/g. The ^{232}Th concentrations for these two samples were 6 pCi/g and 3 pCi/g. These concentrations were above those found in other soil samples collected and analyzed at the site. The samples were collected at a depth of 9-10 ft below grade after all of the ^{226}Ra contamination had been removed at 6 ft below grade. The ^{232}Th and total uranium activity concentrations found at this location are assumed to be an indication of the possible variations in the concentration of naturally-occurring radionuclides.

Uranium fluorometric analyses performed on three samples from an ash pit showed total uranium concentrations of 2.8 pCi/g; 3.4 pCi/g, and 17.0 pCi/g. The individual residing in the 107 duplex was supposedly in the ash collection business for a period of time. We have surmised that this elevated level of radioactivity is due to the coal residue concentrates which were disposed in this pit. Reported values for ^{238}U alone in coal residues (ash, slag, fly ash) can range up to 10 pCi/g, owing to the wide variability in coal constituents (UNSCEAR 77). The possibility exists that Reading Prong Pennsylvania coal may have been used for heating homes in this area. The Reading Prong region of Pennsylvania has been identified as an area with elevated levels of natural uranium deposits.

8.3 Results of Gamma Spectrometry Analyses Conducted on Various Samples by the Analytical Chemistry Laboratory (ACL)

- ^{226}Ra -- Table 10 includes special samples analyzed by ACL for the presence of radium contamination. The special samples were materials such as fragmented brick, insulation, and chunks of mortar. The highest radium concentration found was 2.0E6 pCi/g in a brick sample from the 105 basement chimney. The highest levels of ^{226}Ra contamination in the soil samples submitted to ACL for analysis ranged from 900-7500 pCi/g collected from various locations on the property.
- ^{232}Th and ^{40}K -- Shown in Table 11 is a listing of the samples analyzed using techniques of gamma spectrometry. The measured ^{232}Th concentrations are not considered out of the ordinary, the average concentration from a group of soil verification samples was 1.07 pCi/g. The ^{40}K concentrations in the soil samples analyzed was quite ordinary, nominally 30 pCi/g.

TABLE 10 Ra-226 Analyses Performed on Various Types of Samples

Sample No.	Sample Location	Ra-226 (186 keV) pCi/g \pm σ			Pb-214 (352 keV) pCi/g \pm σ			Bi-214 (609 keV) pCi/g \pm σ		
		--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
Verification Soil Samples										
*22-S-652	5L 0-35	3.05 \pm 0.60	5.09 \pm 0.94	NA	2.10 \pm 0.11	2.64 \pm 0.19	3.66 \pm 0.04	2.07 \pm 0.12	4.05 \pm 0.22	3.77 \pm 0.05
*22-S-645	35L 0-15	1.96 \pm 0.71	4.10 \pm 0.91	NA	1.56 \pm 0.10	1.96 \pm 0.20	2.66 \pm 0.03	2.00 \pm 0.13	2.13 \pm 0.25	2.71 \pm 0.04
*22-S-762	145L 0-15	2.75 \pm 0.51	4.22 \pm 0.67	NA	2.47 \pm 0.10	2.92 \pm 0.12	3.26 \pm 0.08	2.72 \pm 0.12	3.44 \pm 0.15	3.49 \pm 0.11
*22-S-749	65L 0-05	2.19 \pm 0.49	3.36 \pm 0.62	NA	1.86 \pm 0.08	2.40 \pm 0.11	3.85 \pm 0.02	2.16 \pm 0.10	2.49 \pm 0.13	3.96 \pm 0.03
*22-S-742	75L 0-05	3.27 \pm 0.64	4.42 \pm 0.84	NA	1.81 \pm 0.09	1.77 \pm 0.12	3.30 \pm 0.02	2.14 \pm 0.11	2.03 \pm 0.14	3.43 \pm 0.03
*22-S-728	105L 0-05	3.47 \pm 0.53	3.12 \pm 0.65	NA	1.74 \pm 0.09	2.39 \pm 0.13	3.89 \pm 0.02	2.15 \pm 0.12	2.68 \pm 0.15	4.07 \pm 0.02
*22-S-815	5L 0+05	3.40 \pm 0.71	4.99 \pm 0.84	NA	2.77 \pm 0.11	3.44 \pm 0.14	4.56 \pm 0.02	3.14 \pm 0.14	3.10 \pm 0.15	4.70 \pm 0.02
*22-S-527	35L 0+15	3.12 \pm 0.67	3.33 \pm 0.94	NA	1.39 \pm 0.11	2.11 \pm 0.14	3.44 \pm 0.02	1.62 \pm 0.13	2.56 \pm 0.18	3.57 \pm 0.03
*22-S-778	65L 0+15	4.27 \pm 0.80	4.52 \pm 0.95	NA	3.21 \pm 0.13	3.65 \pm 0.17	5.55 \pm 0.05	3.44 \pm 0.16	3.63 \pm 0.21	5.65 \pm 0.07
*22-S-391	105L 0+15	3.77 \pm 0.75	3.18 \pm 0.70	NA	1.41 \pm 0.12	2.02 \pm 0.12	2.94 \pm 0.02	1.69 \pm 0.15	2.11 \pm 0.15	3.07 \pm 0.02
*22-S-858	5R 0+25	5.03 \pm 0.92	5.44 \pm 1.07	NA	2.24 \pm 0.15	6.10 \pm 0.19	5.77 \pm 0.09	2.65 \pm 0.19	5.49 \pm 0.20	5.75 \pm 0.11
*22-S-574	5L 0+25	4.41 \pm 0.81	5.38 \pm 0.91	NA	2.93 \pm 0.13	5.03 \pm 0.18	7.02 \pm 0.05	3.06 \pm 0.16	5.05 \pm 0.22	7.17 \pm 0.05
*22-S-871	165L 0+25	2.99 \pm 0.83	6.14 \pm 1.20	NA	1.83 \pm 0.15	3.58 \pm 0.17	4.63 \pm 0.08	2.10 \pm 0.18	3.21 \pm 0.16	4.33 \pm 0.09
*22-S-915	15R 0+35	2.59 \pm 0.90	6.96 \pm 0.98	NA	1.28 \pm 0.15	2.73 \pm 0.15	3.95 \pm 0.10	1.26 \pm 0.17	2.34 \pm 0.15	3.83 \pm 0.12
*22-S-859	5R 0+35	3.58 \pm 0.75	5.00 \pm 1.06	NA	1.90 \pm 0.14	4.20 \pm 0.17	5.66 \pm 0.09	2.05 \pm 0.18	4.16 \pm 0.18	5.91 \pm 0.14
*22-S-541	85L 0+35	5.79 \pm 0.81	5.89 \pm 1.03	NA	2.72 \pm 0.13	4.13 \pm 0.18	2.85 \pm 0.03	3.25 \pm 0.16	4.84 \pm 0.21	3.03 \pm 0.05
*22-S-894	175L 0+55	5.10 \pm 1.00	8.11 \pm 1.05	NA	2.24 \pm 0.16	4.69 \pm 0.17	5.34 \pm 0.08	2.38 \pm 0.18	4.70 \pm 0.20	5.25 \pm 0.10
*22-S-584	15L 0+65	2.93 \pm 0.66	NA	NA	1.38 \pm 0.10	NA	2.94 \pm 0.02	1.83 \pm 0.12	NA	3.03 \pm 0.02
*22-S-476	75L 0+65	3.96 \pm 0.81	4.91 \pm 0.92	NA	1.44 \pm 0.11	1.72 \pm 0.12	2.40 \pm 0.02	1.54 \pm 0.13	1.86 \pm 0.14	2.46 \pm 0.03
*22-S-378	135L 0+65	4.26 \pm 0.71	3.62 \pm 0.74	NA	1.70 \pm 0.12	2.63 \pm 0.13	3.64 \pm 0.03	2.25 \pm 0.16	2.55 \pm 0.15	3.79 \pm 0.04
*22-S-370	145L 0+65	3.02 \pm 0.59	2.94 \pm 0.53	NA	1.65 \pm 0.10	1.96 \pm 0.11	3.55 \pm 0.04	2.26 \pm 0.14	2.36 \pm 0.12	3.60 \pm 0.05
*22-S-875	155L 0+65	4.55 \pm 1.14	7.05 \pm 1.07	NA	2.27 \pm 0.16	4.91 \pm 0.19	4.83 \pm 0.11	2.39 \pm 0.20	4.21 \pm 0.20	4.84 \pm 0.11
*22-S-863	5R 0+75	2.86 \pm 0.98	6.34 \pm 0.94	NA	1.61 \pm 0.14	3.71 \pm 0.16	3.61 \pm 0.09	1.57 \pm 0.17	3.58 \pm 0.17	3.76 \pm 0.12
*22-S-495	75L 0+75	2.62 \pm 0.71	4.91 \pm 0.90	NA	1.98 \pm 0.12	2.38 \pm 0.13	3.26 \pm 0.03	1.74 \pm 0.15	2.46 \pm 0.16	3.30 \pm 0.03
*22-S-694	135L 0+75	1.71 \pm 0.64	4.73 \pm 1.24	NA	1.57 \pm 0.12	2.30 \pm 0.14	2.86 \pm 0.03	1.55 \pm 0.13	2.84 \pm 0.18	2.85 \pm 0.05
*22-S-906	5R 0+95	4.55 \pm 1.08	6.12 \pm 1.03	NA	1.84 \pm 0.15	3.67 \pm 0.17	5.51 \pm 0.10	2.34 \pm 0.20	3.96 \pm 0.18	5.92 \pm 0.16
*22-S-822	5L 0+95	3.29 \pm 0.67	5.45 \pm 0.93	NA	2.99 \pm 0.13	3.79 \pm 0.16	5.29 \pm 0.08	3.41 \pm 0.15	4.07 \pm 0.17	5.23 \pm 0.09
*22-S-480	85L 0+95	3.31 \pm 0.86	3.82 \pm 0.68	NA	1.35 \pm 0.11	2.05 \pm 0.12	2.25 \pm 0.03	1.77 \pm 0.13	1.77 \pm 0.14	2.34 \pm 0.04
*22-S-907	5R 1+05	4.29 \pm 1.08	7.59 \pm 1.06	NA	2.53 \pm 0.16	5.41 \pm 0.20	5.14 \pm 0.13	2.81 \pm 0.19	5.31 \pm 0.21	5.14 \pm 0.16
*22-S-805	15L 1+05	5.46 \pm 0.71	7.93 \pm 0.91	NA	3.90 \pm 0.13	5.5C \pm 0.17	6.79 \pm 0.04	4.57 \pm 0.16	5.26 \pm 0.18	7.12 \pm 0.04
*22-S-879	155L 1+05	3.32 \pm 0.92	4.07 \pm 1.09	NA	1.77 \pm 0.15	3.66 \pm 0.16	3.77 \pm 0.06	2.09 \pm 0.18	3.70 \pm 0.18	3.84 \pm 0.06
*22-S-922	165R 1+05	5.44 \pm 1.04	7.43 \pm 1.16	NA	2.28 \pm 0.17	5.04 \pm 0.20	7.16 \pm 0.11	2.91 \pm 0.21	4.93 \pm 0.20	7.06 \pm 0.13

TABLE 10 (Cont'd)

Sample No.	Sample Location	Ra-226 (186 keV)			Pb-214 (352 keV)			Bi-214 (609 keV)		
		--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
		pCi/g $\pm \sigma$			pCi/g $\pm \sigma$			pCi/g $\pm \sigma$		
*22-S-908	5R 1+15	4.60 \pm 0.85	7.57 \pm 1.20	NA	2.45 \pm 0.17	4.82 \pm 0.19	6.28 \pm 0.14	3.12 \pm 0.21	4.77 \pm 0.20	5.83 \pm 0.15
*22-S-679	15L 1+15	5.48 \pm 0.87	3.63 \pm 0.78	NA	1.95 \pm 0.11	3.34 \pm 0.15	3.58 \pm 0.03	2.23 \pm 0.15	4.09 \pm 0.18	3.72 \pm 0.03
*22-S-796	35L 1+15	4.14 \pm 0.64	8.04 \pm 0.97	NA	3.11 \pm 0.12	4.21 \pm 0.15	5.33 \pm 0.04	3.71 \pm 0.15	4.03 \pm 0.16	5.49 \pm 0.05
*22-S-708	55L 1+25	1.33 \pm 0.61	4.16 \pm 0.92	NA	1.93 \pm 0.10	2.26 \pm 0.15	3.13 \pm 0.02	1.94 \pm 0.13	2.33 \pm 0.18	3.20 \pm 0.03
*22-S-721	125L 1+25	3.81 \pm 0.63	2.79 \pm 0.78	NA	1.48 \pm 0.09	1.14 \pm 0.12	1.91 \pm 0.02	1.69 \pm 0.12	1.39 \pm 0.15	1.95 \pm 0.02
*22-S-911	5R 1+45	BDL	5.08 \pm 0.81	NA	1.13 \pm 0.12	1.58 \pm 0.12	3.12 \pm 0.05	1.20 \pm 0.16	1.58 \pm 0.12	3.30 \pm 0.08
*22-S-790	15L 1+45	4.06 \pm 0.70	5.57 \pm 0.85	NA	3.42 \pm 0.12	4.16 \pm 0.17	6.10 \pm 0.04	3.57 \pm 0.16	4.29 \pm 0.19	6.37 \pm 0.05
*22-S-699	145L 1+45	2.47 \pm 0.66	BDL	NA	1.40 \pm 0.11	2.21 \pm 0.13	2.65 \pm 0.03	1.59 \pm 0.13	2.70 \pm 0.17	2.71 \pm 0.04
*22-S-675	165L 1+55	3.35 \pm 0.67	5.09 \pm 0.80	NA	1.94 \pm 0.11	3.08 \pm 0.14	4.01 \pm 0.05	2.06 \pm 0.12	3.52 \pm 0.16	4.15 \pm 0.05
*22-S-839	65L 1+65	3.57 \pm 0.66	6.32 \pm 0.95	NA	1.79 \pm 0.12	2.90 \pm 0.14	3.59 \pm 0.06	1.88 \pm 0.14	2.76 \pm 0.15	3.34 \pm 0.07
*22-S-519	55L 1+75	4.14 \pm 0.63	5.46 \pm 0.87	NA	1.50 \pm 0.09	2.59 \pm 0.15	3.52 \pm 0.02	1.53 \pm 0.11	2.84 \pm 0.17	3.68 \pm 0.03
*22-S-557	75L 1+75	1.74 \pm 0.60	4.45 \pm 0.80	NA	1.26 \pm 0.10	2.00 \pm 0.13	3.02 \pm 0.03	1.50 \pm 0.11	2.17 \pm 0.16	3.06 \pm 0.03
*22-S-590	135L 1+75	4.20 \pm 0.62	NA	NA	2.02 \pm 0.09	NA	5.13 \pm 0.04	2.09 \pm 0.11	NA	5.36 \pm 0.06
*22-S-610	255L 1+85	BDL	NA	NA	1.06 \pm 0.09	NA	2.32 \pm 0.02	1.13 \pm 0.11	NA	2.37 \pm 0.02
*22-S-634	75L 1+85	4.36 \pm 0.65	5.70 \pm 0.92	NA	1.46 \pm 0.09	2.93 \pm 0.19	4.62 \pm 0.03	1.77 \pm 0.10	3.13 \pm 0.23	4.76 \pm 0.03
Ave		3.63	5.21		1.99	3.22	4.12	2.26	3.33	4.20
Std dev		1.05	1.46		0.64	1.21	1.33	0.73	1.11	1.33
Max		5.79	8.11		3.90	6.10	7.16	4.57	5.49	7.17
Min		1.33	2.79		1.06	1.14	1.91	1.13	1.39	1.95
No of Samples		47	43		47	44	47	47	44	47
Miscellaneous Soil Samples										
*22-S-002	65L 1+05	1910. \pm 38.0	NA	NA	770. \pm 6.60	NA	1670.6 \pm 1.7	1000. \pm 9.50	NA	1631.9 \pm 1.60
*22-S-003	75L 0+05	4680. \pm 16.20	NA	NA	3280. \pm 2.88	NA	5848.5 \pm 24.0	4140. \pm 5.17	NA	5774.3 \pm 25.2
*22-S-009	65L 0+35 4"	453. \pm 9.76	NA	NA	390. \pm 2.16	NA	1984. \pm 4.0	538. \pm 3.08	NA	2094. \pm 2.00
*22-S-009	65L 0+35 4"	453. \pm 9.76	NA	NA	390. \pm 2.16	NA	1844. \pm 6.0	538. \pm 3.08	NA	1902. \pm 4.00
*22-S-010	75L 0+05 4"	256. \pm 6.84	NA	NA	220. \pm 1.55	NA	1078. \pm 2.0	300. \pm 2.22	NA	1111. \pm 1.00
*22-S-011	55L 0+15 4"	200. \pm 5.62	NA	NA	174. \pm 1.28	NA	926. \pm 2.0	234. \pm 1.81	NA	943. \pm 2.00
*22-S-012	55L 0+15 8"	982. \pm 12.3	NA	NA	840. \pm 2.97	NA	7570. \pm 6.0	140. \pm 4.06	NA	7501. \pm 18.00
*22-S-033	94L 0+13 1"	7.01 \pm 0.27	NA	NA	5.60 \pm 0.06	NA	10.20 \pm 0.13	7.07 \pm 0.09	NA	9.99 \pm 0.15
*22-S-033	94L 0+13 1"	7.01 \pm 0.27	NA	NA	5.60 \pm 0.06	NA	14.52 \pm 0.16	7.07 \pm 0.09	NA	14.54 \pm 0.19
*22-S-036	84L 0+23 17"	10.8 \pm 0.52	NA	NA	6.01 \pm 0.09	NA	30.03 \pm 0.33	7.42 \pm 0.13	NA	28.27 \pm 0.20
*22-S-036	84L 0+23 17"	10.8 \pm 0.52	NA	NA	6.01 \pm 0.09	NA	29.41 \pm 0.24	7.42 \pm 0.13	NA	28.50 \pm 0.20
*22-S-039	84L 0+23 20"	7.18 \pm 0.46	NA	NA	4.49 \pm 0.09	NA	9.45 \pm 0.17	5.66 \pm 0.12	NA	9.31 \pm 0.13
*22-S-039	84L 0+23 20"	7.18 \pm 0.46	NA	NA	4.49 \pm 0.09	NA	9.84 \pm 0.15	5.66 \pm 0.12	NA	9.56 \pm 0.11

TABLE 10 (Cont'd)

Sample No.	Sample Location	Ra-226 (186 keV)			Pb-214 (352 keV)			Bi-214 (609 keV)		
		--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
		pCi/g $\pm \sigma$			pCi/g $\pm \sigma$			pCi/g $\pm \sigma$		
*22-S-064	5L 0+15	3.25 \pm 0.55	NA	NA	1.65 \pm 0.10	NA	4.10 \pm 0.07	2.27 \pm 0.13	NA	4.09 \pm 0.10
*22-S-065	5L 0+05	2.97 \pm 0.50	NA	NA	1.65 \pm 0.09	NA	3.32 \pm 0.07	1.90 \pm 0.12	NA	3.44 \pm 0.08
*22-S-067	15L 0+05	2.88 \pm 0.65	NA	NA	1.45 \pm 0.10	NA	3.34 \pm 0.07	1.37 \pm 0.13	NA	3.32 \pm 0.07
*22-S-068	15L 0+15	2.30 \pm 0.68	NA	NA	1.45 \pm 0.10	NA	2.81 \pm 0.08	1.84 \pm 0.12	NA	2.68 \pm 0.08
*22-S-074	25L 0+05	1.19 \pm 0.44	NA	NA	0.64 \pm 0.07	NA	1.57 \pm 0.06	0.79 \pm 0.10	NA	1.56 \pm 0.08
*22-S-075	25L 0+15	1.98 \pm 0.45	NA	NA	1.18 \pm 0.08	NA	4.68 \pm 0.10	1.40 \pm 0.11	NA	4.50 \pm 0.11
*22-S-077	5L 0+25	1.90 \pm 0.46	NA	NA	1.04 \pm 0.08	NA	2.63 \pm 0.04	1.27 \pm 0.11	NA	2.66 \pm 0.05
*22-S-078	15L 0+25	1.23 \pm 0.39	NA	NA	1.20 \pm 0.09	NA	2.83 \pm 0.09	1.35 \pm 0.11	NA	2.60 \pm 0.08
*22-S-080	15L 0+45	6.09 \pm 0.75	NA	NA	3.09 \pm 0.15	NA	8.35 \pm 0.09	4.38 \pm 0.21	NA	8.41 \pm 0.08
*22-S-082	5L 0+35	3.01 \pm 0.56	NA	NA	1.57 \pm 0.10	NA	4.25 \pm 0.07	2.08 \pm 0.13	NA	4.21 \pm 0.08
*22-S-160	15L 1+15	4.65 \pm 0.87	NA	NA	3.24 \pm 0.16	NA	7.88 \pm 0.07	3.66 \pm 0.23	NA	8.06 \pm 0.08
*22-S-189	Hole 191 Reg 83	13.0 \pm 0.97	11.9 \pm 1.13	20.8 \pm 1.56	8.57 \pm 0.21	10.9 \pm 0.23	15.2 \pm 0.29	10.4 \pm 0.29	13.8 \pm 0.32	15.0 \pm 0.31
*22-S-190	Hole 191 Reg 83	10.1 \pm 0.83	10.2 \pm 0.89	15.6 \pm 1.40	5.46 \pm 0.16	8.20 \pm 0.19	11.8 \pm 0.24	6.75 \pm 0.22	10.1 \pm 0.26	11.1 \pm 0.26
*22-S-215	25L 0+55	3.17 \pm 0.61	NA	NA	1.46 \pm 0.10	NA	3.76 \pm 0.08	1.89 \pm 0.15	NA	3.92 \pm 0.11
*22-S-228	5L 1+05	5.02 \pm 0.7	NA	NA	2.41 \pm 0.12	NA	6.58 \pm 0.09	2.67 \pm 0.17	NA	6.84 \pm 0.11
*22-S-239	5L 1+45	2.64 \pm 0.58	NA	NA	2.36 \pm 0.11	NA	6.30 \pm 0.09	3.07 \pm 0.15	NA	5.96 \pm 0.12
*22-S-298	Hole 347 Reg 104	5.01 \pm 0.69	4.65 \pm 0.75	8.49 \pm 1.13	1.83 \pm 0.13	2.65 \pm 0.14	4.00 \pm 0.18	1.95 \pm 0.16	3.12 \pm 0.17	3.89 \pm 0.19
*22-S-298	Hole 347 Reg 104	5.01 \pm 0.69	4.65 \pm 0.75	NA	1.83 \pm 0.13	2.65 \pm 0.14	2.83 \pm 0.07	1.95 \pm 0.16	3.12 \pm 0.17	2.59 \pm 0.09
*22-S-299	Hole 347 Reg 104	3.66 \pm 0.58	2.99 \pm 0.56	5.83 \pm 1.05	1.30 \pm 0.10	2.36 \pm 0.11	3.18 \pm 0.14	1.14 \pm 0.13	2.64 \pm 0.15	3.11 \pm 0.15
*22-S-300	Hole 347 Reg 104	4.42 \pm 0.68	5.26 \pm 0.71	9.29 \pm 1.09	1.70 \pm 0.11	2.88 \pm 0.13	4.11 \pm 0.17	2.00 \pm 0.14	3.50 \pm 0.18	3.96 \pm 0.18
*22-S-300	Hole 347 Reg 104	4.42 \pm 0.68	5.26 \pm 0.71	NA	1.70 \pm 0.11	2.88 \pm 0.13	3.48 \pm 0.09	2.00 \pm 0.14	3.50 \pm 0.18	3.22 \pm 0.08
*22-S-300	Hole 347 Reg 104	4.42 \pm 0.68	5.26 \pm 0.71	NA	1.70 \pm 0.11	2.88 \pm 0.13	2.89 \pm 0.07	2.00 \pm 0.14	3.50 \pm 0.18	3.02 \pm 0.08
*22-S-301	Hole 347 Reg 104	2.01 \pm 0.56	2.37 \pm 0.55	2.42 \pm 0.85	0.89 \pm 0.09	1.22 \pm 0.10	2.09 \pm 0.12	1.09 \pm 0.12	1.48 \pm 0.13	2.02 \pm 0.13
*22-S-437	275L 1+85	2.39 \pm 0.51	2.10 \pm 0.52	NA	1.73 \pm 0.09	2.01 \pm 0.10	3.45 \pm 0.03	1.94 \pm 0.11	2.44 \pm 0.12	3.60 \pm 0.04
*22-S-457	185L 1+85	1.41 \pm 0.63	1.62 \pm 0.57	NA	1.45 \pm 0.09	1.74 \pm 0.09	2.89 \pm 0.03	1.73 \pm 0.12	1.99 \pm 0.12	3.06 \pm 0.05
*22-S-504	155L 1+75	21.8 \pm 1.23	18.9 \pm 1.38	NA	19.8 \pm 0.28	19.9 \pm 0.32	16.33 \pm 0.08	22.2 \pm 0.35	22.1 \pm 0.39	16.7 \pm 0.08
*22-S-857	5R 0+15	4.78 \pm 0.88	5.10 \pm 0.92	NA	1.91 \pm 0.14	4.69 \pm 0.16	5.06 \pm 0.14	2.10 \pm 0.17	4.37 \pm 0.18	4.86 \pm 0.15
Ave		222.28	6.17	10.41	150.57	5.00	516.38	195.64	5.82	517.15
Std dev		780.97	4.65	6.12	529.86	5.06	1503.88	673.44	5.78	1493.36
Max		4680.00	18.90	20.80	3280.00	19.90	7570.00	4140.00	22.10	7501.00
Min		1.19	1.62	2.42	0.64	1.22	1.57	0.79	1.48	1.56
No of Samples		41	13	6	41	13	41	41	13	41

TABLE 10 (Cont'd)

Sample No.	Sample Location	Ra-226 (186 keV)			Pb-214 (352 keV)			Bi-214 (609 keV)		
		--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
		pCi/g $\pm \sigma$								
Backfill and Top Soil										
*22-SB-069	backfill #1	BDL	NA	NA	0.13 \pm 0.04	NA	0.31 \pm 0.05	0.16 \pm 0.06	NA	0.29 \pm 0.06
*22-SB-070	backfill #2	2.26 \pm 0.65	NA	NA	0.45 \pm 0.09	NA	1.13 \pm 0.05	0.64 \pm 0.13	NA	1.08 \pm 0.05
*22-SB-071	backfill #3	BDL	NA	NA	0.23 \pm 0.07	NA	0.25 \pm 0.05	BDL	NA	0.29 \pm 0.05
*22-SB-072	backfill #4	BDL	NA	NA	BDL	NA	0.18 \pm 0.05	0.19 \pm 0.07	NA	0.20 \pm 0.06
*22-SB-072	backfill #4	BDL	NA	NA	BDL	NA	0.20 \pm 0.04	0.10 \pm 0.07	NA	BDL
*22-SB-073	backfill #4	1.13 \pm 0.49	NA	NA	0.31 \pm 0.08	NA	0.98 \pm 0.03	0.42 \pm 0.11	NA	0.98 \pm 0.04
*22-SB-076	backfill #5	BDL	NA	NA	BDL	NA	0.16 \pm 0.03	BDL	NA	BDL
*22-SB-851	backfill #3	BDL	BDL	NA	0.11 \pm 0.06	0.26 \pm 0.06	0.61 \pm 0.04	0.11 \pm 0.06	0.27 \pm 0.06	0.66 \pm 0.04
*22-SB-928	top soil	BDL	1.46 \pm 0.63	NA	0.43 \pm 0.10	0.60 \pm 0.08	1.01 \pm 0.06	0.46 \pm 0.13	0.49 \pm 0.09	1.19 \pm 0.08
Ave		1.72			0.28	0.43	0.54	0.28	0.38	0.67
Std dev		0.54			0.13	0.17	0.38	0.20	0.11	0.39
Max		2.26			0.45	0.60	1.13	0.84	0.49	1.19
Min		1.18			0.11	0.26	0.16	0.10	0.27	0.20
No of Samples		2			6	2	9	7	2	7
Miscellaneous Samples										
*22-Z-001	105 wood	NA	NA	NA	NA	NA	309.8 \pm 3.20	NA	NA	311.90 \pm 2.30
*22-Z-007	105 brick	1270. \pm 20.00	NA	NA	969. \pm 3.69	NA	1.82E6 \pm 0.3E6	926.0 \pm 3.92	NA	2.14E6 \pm 0.4E6
*22-Z-008	105 insulation	19.7 \pm 0.88	NA	NA	16.7 \pm 0.21	NA	29.3 \pm 0.21	21.2 \pm 0.30	NA	30.73 \pm 0.31
*22-Z-008	105 insulation	19.7 \pm 0.88	NA	NA	16.7 \pm 0.21	NA	50.35 \pm 0.21	21.2 \pm 0.30	NA	51.66 \pm 0.27
*22-Z-015	105 chimney tile	1.41 \pm 0.46	NA	NA	1.13 \pm 0.08	NA	2.38 \pm 0.06	1.46 \pm 0.11	NA	2.39 \pm 0.06
*22-Z-015	105 chimney tile	1.41 \pm 0.46	NA	NA	1.13 \pm 0.08	NA	2.73 \pm 0.07	1.46 \pm 0.11	NA	2.67 \pm 0.06
*22-Z-017	107 chimney tile	0.62 \pm 0.20	NA	NA	0.50 \pm 0.04	NA	1.02 \pm 0.07	0.63 \pm 0.05	NA	1.11 \pm 0.08
*22-Z-017	107 chimney tile	0.62 \pm 0.20	NA	NA	0.50 \pm 0.04	NA	1.10 \pm 0.05	0.63 \pm 0.05	NA	1.11 \pm 0.05
*22-Z-018	107 chimney brick	0.67 \pm 0.07	NA	NA	0.60 \pm 0.02	NA	1.25 \pm 0.07	0.82 \pm 0.02	NA	1.44 \pm 0.07
*22-Z-018	107 chimney brick	0.67 \pm 0.07	NA	NA	0.60 \pm 0.02	NA	5.77 \pm 0.08	0.82 \pm 0.02	NA	5.88 \pm 0.11
*22-Z-020	105 mortar	1740. \pm 37.40	NA	NA	1560. \pm 9.60	NA	1870. \pm 10.00	1940. \pm 13.10	NA	1900. \pm 10.00
*22-Z-021	107 chimney brick	7.17 \pm 0.44	NA	NA	7.73 \pm 0.10	NA	38.82 \pm 0.12	10.5 \pm 0.14	NA	39.42 \pm 0.16
*22-Z-021	107 chimney brick	7.17 \pm 0.44	NA	NA	7.73 \pm 0.10	NA	14.9 \pm 0.10	10.5 \pm 0.14	NA	15.48 \pm 0.14
*22-Z-022	107 chimney brick	BDL	NA	NA	0.28 \pm 0.02	NA	3.00 \pm 0.08	0.31 \pm 0.03	NA	3.07 \pm 0.13
*22-Z-028	sewer sludge	NA	NA	NA	NA	NA	1.82 \pm 0.04	NA	NA	1.82 \pm 0.06
*22-Z-028	sewer sludge	NA	NA	NA	NA	NA	1.92 \pm 0.06	NA	NA	1.94 \pm 0.06

TABLE 10 (Cont'd)

Sample No.	Sample Location	Ra-226 (186 keV)				Pb-214 (352 keV)				Bi-214 (609 keV)			
		--Initial--	--Aged--	--Dried--		--Initial--	--Aged--	--Dried--		--Initial--	--Aged--	--Dried--	
			pCi/g $\pm \sigma$				pCi/g $\pm \sigma$				pCi/g $\pm \sigma$		
*22-Z-054	concrete 105	14.2 \pm 3.35	NA	NA		6.29 \pm 0.43	NA	12.1 \pm 0.08		6.74 \pm 0.46	NA	12.35 \pm 0.10	
*22-Z-066	concrete 105	BDL	NA	NA		2.57 \pm 0.23	NA	2.25 \pm 0.08		2.39 \pm 0.23	NA	2.21 \pm 0.09	
*22-Z-555	ash 15L 0-05	32.8 \pm 1.53	32.6 \pm 1.59	NA		17.5 \pm 0.28	30.00 \pm 0.37	34.43 \pm 0.21		21.3 \pm 0.35	33.4 \pm 0.46	5.01 \pm 0.22	
*22-Z-555	ash 15L 0-05	32.8 \pm 1.53	32.6 \pm 1.59	NA		17.5 \pm 0.28	30.00 \pm 0.37	51.25 \pm 0.311		21.3 \pm 0.35	33.4 \pm 0.46	52.40 \pm 0.37	
*22-Z-556	ash 15L 0-05	49.8 \pm 1.70	49.6 \pm 1.99	NA		25.3 \pm 0.32	44.40 \pm 0.45	62.98 \pm 0.511		28.9 \pm 0.41	50.0 \pm 0.55	63.46 \pm 0.64	
*22-Z-558	ash 15L 0-05	27.5 \pm 1.43	29.4 \pm 1.62	NA		14.0 \pm 0.26	26.20 \pm 0.36	42.26 \pm 0.211		15.6 \pm 0.33	29.1 \pm 0.46	42.71 \pm 0.30	
22-Z-625	glass 19L 0-40	5.48E4 \pm 0.12E4	NA	NA		4.32E4 \pm 2.5E2	NA	NA		5.92E4 \pm 4.1E2	NA	NA	
Ave		189.78	36.05			140.30	32.65	120.93		159.57	36.48	122.80	
Std dev		487.17	7.93			397.41	6.96	396.45		466.82	8.00	402.73	
Max		1740.	49.6			1560.	44.4	1430.		1940.	50.0	1900.	
Min		0.62	29.4			0.28	26.2	1.02		0.31	29.1	1.11	
No of Samples		18	4			19	4	11		19	4	21	
Smears													
*22-Z-004	105 basement floor	NA	NA	NA		NA	NA	pCi/Filter $\pm \sigma$		NA	NA	pCi/Filter $\pm \sigma$	
*22-Z-016	105 kitchen sink	NA	NA	NA		NA	NA	3294.4 \pm 13.3		NA	NA	3398. \pm 13.8	
								5310. \pm 60.0		NA	NA	5520. \pm 60.0	

*Samples dried and analyzed by the ACL.

 σ Uncertainty in the counting statistics.

NA = Data Not Available; ACL does not report the 186 keV activity.

BDL = Below Detectable Level.

TABLE 11 Th-232 and K-40 Analyses Performed on Various Types of Samples

Sample No.	Sample Location	Z Wt	Th-232 (911 keV) pCi/g \pm σ			K-40 (1460 keV) pCi/g \pm σ		
			--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
Verification Soil Samples								
*22-S-652	5L 0-35	94.3	0.94 \pm 0.21	0.82 \pm 0.34	1.01 \pm 0.05	17.4 \pm 1.3	14.0 \pm 1.8	16.1 \pm 0.4
*22-S-645	35L 0-15	91.9	0.93 \pm 0.25	1.20 \pm 0.36	1.05 \pm 0.04	17.3 \pm 1.4	15.3 \pm 2.1	15.3 \pm 0.4
*22-S-762	145L 0-15	79.9	0.76 \pm 0.18	0.79 \pm 0.24	0.83 \pm 0.03	13.7 \pm 0.9	12.9 \pm 1.3	9.3 \pm 0.4
*22-S-749	65L 0-05	82.7	0.82 \pm 0.17	1.30 \pm 0.22	1.20 \pm 0.02	14.5 \pm 1.0	12.5 \pm 1.2	15.2 \pm 0.2
*22-S-742	75L 0-05	80.0	0.85 \pm 0.17	1.10 \pm 0.22	1.12 \pm 0.03	15.3 \pm 1.1	15.9 \pm 1.4	17.4 \pm 0.2
*22-S-728	105L 0-05	82.6	1.03 \pm 0.17	1.24 \pm 0.26	1.26 \pm 0.03	18.2 \pm 1.1	16.7 \pm 1.5	18.5 \pm 0.2
*22-S-815	5L 0+05	83.3	1.60 \pm 0.19	1.07 \pm 0.18	1.37 \pm 0.02	21.7 \pm 1.1	12.9 \pm 1.0	18.0 \pm 0.1
*22-S-527	35L 0+15	88.4	1.72 \pm 0.22	1.77 \pm 0.31	1.40 \pm 0.03	26.3 \pm 1.4	19.9 \pm 1.8	18.9 \pm 0.2
*22-S-778	65L 0+15	89.8	0.98 \pm 0.21	2.24 \pm 0.31	0.95 \pm 0.06	24.6 \pm 1.3	18.5 \pm 1.9	18.0 \pm 0.4
*22-S-391	105L 0+15	90.4	2.21 \pm 0.32	1.53 \pm 0.24	1.29 \pm 0.03	32.2 \pm 2.2	21.9 \pm 1.5	19.8 \pm 0.2
*22-S-858	5R 0+25	88.8	1.56 \pm 0.30	1.39 \pm 0.25	1.60 \pm 0.16	16.6 \pm 1.7	15.1 \pm 1.2	14.4 \pm 0.9
*22-S-574	5L 0+25	91.0	1.20 \pm 0.23	1.10 \pm 0.35	1.34 \pm 0.04	17.4 \pm 1.4	17.4 \pm 1.9	16.4 \pm 0.2
*22-S-871	165L 0+25	78.9	0.53 \pm 0.28	1.18 \pm 0.19	1.31 \pm 0.12	17.2 \pm 1.7	14.3 \pm 1.1	17.7 \pm 0.7
*22-S-915	15R 0+35	75.9	0.58 \pm 0.33	1.05 \pm 0.20	1.54 \pm 0.16	12.1 \pm 1.7	10.6 \pm 1.1	16.7 \pm 0.9
*22-S-859	5R 0+35	87.1	1.08 \pm 0.29	0.53 \pm 0.23	1.34 \pm 0.14	11.5 \pm 1.7	14.6 \pm 1.2	13.6 \pm 1.0
*22-S-541	85L 0+35	89.6	0.84 \pm 0.22	0.86 \pm 0.34	0.92 \pm 0.05	25.6 \pm 1.5	20.0 \pm 1.9	16.6 \pm 0.4
*22-S-894	175L 0+55	74.8	0.76 \pm 0.30	1.10 \pm 0.22	1.54 \pm 0.12	16.3 \pm 1.8	14.8 \pm 1.2	18.3 \pm 0.8
*22-S-584	15L 0+65	90.8	1.47 \pm 0.20	NA	1.34 \pm 0.03	23.6 \pm 1.3	NA	17.2 \pm 0.2
*22-S-475	75L 0+65	87.7	0.81 \pm 0.22	1.07 \pm 0.22	1.22 \pm 0.03	17.5 \pm 1.4	13.0 \pm 1.4	13.7 \pm 0.2
*22-S-778	135L 0+65	83.0	1.39 \pm 0.29	1.71 \pm 0.24	1.05 \pm 0.04	24.1 \pm 2.0	24.6 \pm 1.4	19.5 \pm 0.3
*22-S-370	145L 0+65	77.9	1.06 \pm 0.24	1.16 \pm 0.20	1.03 \pm 0.05	20.5 \pm 1.6	13.8 \pm 1.1	17.2 \pm 0.4
*22-S-875	155L 0+65	86.4	1.14 \pm 0.33	0.74 \pm 0.23	1.55 \pm 0.16	15.1 \pm 1.9	16.9 \pm 1.3	21.3 \pm 0.9
*22-S-863	5R 0+75	76.7	0.94 \pm 0.28	0.77 \pm 0.21	1.45 \pm 0.15	13.2 \pm 1.7	10.8 \pm 1.1	15.5 \pm 0.8
*22-S-495	75L 0+75	88.0	1.03 \pm 0.25	1.44 \pm 0.22	1.21 \pm 0.03	18.4 \pm 1.5	17.8 \pm 1.5	15.9 \pm 0.2
*22-S-694	135L 0+75	87.5	1.35 \pm 0.23	1.42 \pm 0.31	1.36 \pm 0.05	17.7 \pm 1.4	15.0 \pm 1.9	19.2 \pm 0.4
*22-S-905	5R 0+95	75.9	0.51 \pm 0.32	0.94 \pm 0.22	1.54 \pm 0.18	13.0 \pm 1.8	10.7 \pm 1.1	13.9 \pm 1.1
*22-S-822	5L 0+95	74.5	1.13 \pm 0.21	0.76 \pm 0.21	1.34 \pm 0.07	15.9 \pm 1.2	10.5 \pm 1.1	15.0 \pm 0.4
*22-S-480	85L 0+95	88.6	1.26 \pm 0.23	1.15 \pm 0.22	1.22 \pm 0.06	24.5 \pm 1.3	22.6 \pm 1.4	16.6 \pm 0.5
*22-S-907	5R 1+05	76.3	0.64 \pm 0.30	0.59 \pm 0.23	1.44 \pm 0.17	14.6 \pm 1.8	10.7 \pm 1.2	18.7 \pm 1.0
*22-S-305	15L 1+05	81.3	0.86 \pm 0.23	0.74 \pm 0.21	0.95 \pm 0.04	17.1 \pm 1.0	11.9 \pm 1.0	14.7 \pm 0.3
*22-S-879	155L 1+05	87.1	0.86 \pm 0.29	0.94 \pm 0.22	1.60 \pm 0.07	16.1 \pm 1.8	13.7 \pm 1.2	18.0 \pm 0.4
*22-S-922	165R 1+05	78.9	0.73 \pm 0.33	1.31 \pm 0.24	1.71 \pm 0.12	17.7 \pm 2.0	16.8 \pm 1.4	21.5 \pm 0.7

TABLE 11 (Cont'd)

Sample No.	Sample Location	Z	Wt	Th-232 (911 keV)			K-40 (1460 keV)		
				pCi/g \pm σ			pCi/g \pm σ		
				--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
*22-S-908	SR 1+15	75.9		1.09 \pm 0.33	0.85 \pm 0.21	1.81 \pm 0.18	14.1 \pm 1.8	11.4 \pm 1.2	17.8 \pm 1.0
*22-S-679	15L 1+15	83.1		1.23 \pm 0.20	0.91 \pm 0.28	1.04 \pm 0.02	14.3 \pm 1.3	14.5 \pm 1.7	14.0 \pm 0.1
*22-S-796	35L 1+15	82.6		0.82 \pm 0.22	1.06 \pm 0.20	0.91 \pm 0.05	15.2 \pm 1.1	12.1 \pm 1.0	15.1 \pm 0.3
*22-S-708	55L 1+25	92.2		0.84 \pm 0.23	0.95 \pm 0.30	1.31 \pm 0.03	21.9 \pm 1.4	15.5 \pm 1.7	19.1 \pm 0.2
*22-S-721	125L 1+25	90.4		1.47 \pm 0.22	1.36 \pm 0.27	1.32 \pm 0.02	20.4 \pm 1.4	16.2 \pm 1.6	20.2 \pm 0.2
*22-S-911	SR 1+45	78.2		0.70 \pm 0.27	0.63 \pm 0.18	1.26 \pm 0.08	9.9 \pm 1.6	8.9 \pm 1.1	14.9 \pm 0.4
*22-S-790	15L 1+45	80.6		1.09 \pm 0.20	1.24 \pm 0.30	0.83 \pm 0.04	13.3 \pm 1.2	13.3 \pm 1.6	13.0 \pm 0.4
*22-S-699	145L 1+45	77.0		0.95 \pm 0.23	0.70 \pm 0.31	1.04 \pm 0.04	13.7 \pm 1.3	14.0 \pm 1.8	14.8 \pm 0.3
*22-S-675	165L 1+55	86.3		0.95 \pm 0.20	1.12 \pm 0.27	1.03 \pm 0.05	13.7 \pm 1.1	13.9 \pm 1.5	15.2 \pm 0.3
*22-S-839	65L 1+65	91.0		1.26 \pm 0.23	0.91 \pm 0.18	1.54 \pm 0.10	15.9 \pm 1.3	16.0 \pm 1.2	14.7 \pm 0.6
*22-S-519	55L 1+75	91.7		1.28 \pm 0.21	1.35 \pm 0.28	1.13 \pm 0.03	17.7 \pm 1.3	16.8 \pm 1.6	17.6 \pm 0.2
*22-S-557	75L 1+75	89.0		1.20 \pm 0.21	1.01 \pm 0.26	1.01 \pm 0.04	18.7 \pm 1.2	13.7 \pm 1.5	17.0 \pm 0.3
*22-S-590	135L 1+75	84.3		1.35 \pm 0.18	NA	1.18 \pm 0.04	21.5 \pm 1.2	NA	20.8 \pm 0.4
*22-S-610	255L 1+85	90.6		1.28 \pm 0.18	NA	1.10 \pm 0.03	18.8 \pm 1.2	NA	15.3 \pm 0.2
*22-S-634	75L 1+85	82.1		1.01 \pm 0.18	1.17 \pm 0.29	1.04 \pm 0.02	16.4 \pm 0.9	11.4 \pm 1.8	12.7 \pm 0.1
Ave		84.4		1.07	1.10	1.25	17.7	14.9	16.6
Std dev		5.7		0.33	0.33	0.24	4.4	3.4	2.5
Max		94.3		2.21	2.24	1.81	32.2	24.6	21.5
Min		74.5		0.51	0.53	0.83	9.9	8.9	9.3
No of Samples		47		47	44	47	47	44	47
Miscellaneous Soil Samples									
*22-S-002	65L 1+05	72.2		BDL	NA	2.50 \pm 0.60	BDL	NA	19.2 1.5
*22-S-003	75L 0+05	76.7		BDL	NA	BDL	BDL	NA	BDL
*22-S-009	65L 0+35 4"	83.1		BDL	NA	BDL	BDL	NA	15.8 \pm 2.5
*22-S-009	65L 0+35 4"	83.1		BDL	NA	BDL	BDL	NA	12.4 \pm 3.1
*22-S-010	75L 0+05 4"	80.3		BDL	NA	BDL	26.2 \pm 7.6	NA	16.4 \pm 2.4
*22-S-011	55L 0+15 4"	85.8		BDL	NA	BDL	20.5 \pm 6.4	NA	18.4 \pm 2.2
*22-S-012	55L 0+15 8"	86.4		BDL	NA	BDL	BDL	NA	BDL
*22-S-033	94L 0+13 1"	81.1		1.39 \pm 0.14	NA	1.84 \pm 0.14	19.6 \pm 0.8	NA	19.3 \pm 0.5
*22-S-033	94L 0+13 1"	81.1		1.39 \pm 0.14	NA	2.01 \pm 0.13	19.6 \pm 0.8	NA	21.6 \pm 0.7
*22-S-036	84L 0+23 17"	81.3		1.70 \pm 0.17	NA	2.27 \pm 0.15	21.6 \pm 1.0	NA	22.5 \pm 0.6
*22-S-036	84L 0+23 17"	81.3		1.70 \pm 0.17	NA	1.84 \pm 0.13	21.6 \pm 1.0	NA	21.7 \pm 0.6
*22-S-039	84L 0+23 20"	84.1		1.18 \pm 0.18	NA	1.93 \pm 0.11	22.1 \pm 1.1	NA	22.1 \pm 0.6
*22-S-039	84L 0+23 20"	84.1		1.18 \pm 0.18	NA	1.89 \pm 0.13	22.1 \pm 1.1	NA	21.4 \pm 0.5

TABLE 11 (Cont'd)

Sample No.	Sample Location	% Wt	Th-232 (911 keV) pCi/g \pm σ				K-40 (1460 keV) pCi/g \pm σ			
			--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	--Initial--	--Aged--
*22-S-064	5L 0+15	85.7	2.12 \pm 0.28	NA	1.83 \pm 0.11	27.5 \pm 1.8	NA	21.4 \pm 0.7		
*22-S-065	5L 0+05	84.1	1.36 \pm 0.22	NA	1.77 \pm 0.11	25.7 \pm 1.6	NA	18.9 \pm 0.6		
*22-S-067	15L 0+05	83.0	1.39 \pm 0.25	NA	2.49 \pm 0.12	22.7 \pm 1.6	NA	23.5 \pm 0.8		
*22-S-068	15L 0+15	84.0	1.29 \pm 0.27	NA	1.84 \pm 0.10	28.4 \pm 1.7	NA	19.6 \pm 0.8		
*22-S-074	25L 0+05	83.5	1.44 \pm 0.21	NA	1.46 \pm 0.11	19.4 \pm 1.4	NA	14.7 \pm 0.7		
*22-S-075	25L 0+15	82.4	1.49 \pm 0.23	NA	2.29 \pm 0.11	21.3 \pm 1.5	NA	23.0 \pm 0.5		
*22-S-077	5L 0+25	84.2	1.88 \pm 0.21	NA	1.60 \pm 0.07	24.7 \pm 1.5	NA	22.1 \pm 0.5		
*22-S-078	15L 0+25	84.6	1.80 \pm 0.24	NA	2.02 \pm 0.11	27.0 \pm 1.5	NA	19.6 \pm 0.9		
*22-S-080	15L 0+45	75.3	1.67 \pm 0.33	NA	1.58 \pm 0.09	23.1 \pm 2.0	NA	18.6 \pm 0.5		
*22-S-082	5L 0+35	85.7	1.78 \pm 0.26	NA	1.69 \pm 0.10	26.5 \pm 1.7	NA	20.5 \pm 0.7		
*22-S-160	15L 1+15	77.4	0.20 \pm 0.08	NA	1.37 \pm 0.08	20.2 \pm 2.4	NA	15.2 \pm 0.5		
*22-S-160	15L 1+15	77.4	0.20 \pm 0.08	NA	1.22 \pm 0.13	20.2 \pm 2.4	NA	13.2 \pm 0.9		
22-S-189	Hole 191 Reg 83	74.6	1.06 \pm 0.36	1.19 \pm 0.37	0.59 \pm 0.28	21.2 \pm 2.1	17.2 \pm 2.3	13.5 \pm 1.3		
22-S-190	Hole 191 Reg 83	80.5	0.71 \pm 0.33	1.05 \pm 0.34	1.17 \pm 0.22	24.1 \pm 2.0	26.4 \pm 2.0	14.3 \pm 1.2		
*22-S-215	25L 0+55	87.0	1.61 \pm 0.27	NA	1.6 \pm 0.2	32.0 \pm 1.9	NA	23.6 \pm 0.8		
*22-S-228	5L 1+05	72.0	1.00 \pm 0.29	NA	1.31 \pm 0.09	14.9 \pm 1.7	NA	15.2 \pm 0.5		
*22-S-239	5L 1+45	73.5	1.16 \pm 0.23	NA	1.39 \pm 0.11	19.7 \pm 1.6	NA	15.4 \pm 0.8		
22-S-298	Hole 347 Reg 104	89.9	5.63 \pm 0.41	5.85 \pm 0.42	5.22 \pm 0.35	18.4 \pm 1.9	14.8 \pm 1.7	9.8 \pm 1.1		
*22-S-298	Hole 347 Reg 104	90.6	5.63 \pm 0.41	5.85 \pm 0.42	6.52 \pm 0.14	18.4 \pm 1.9	14.8 \pm 1.7	11.5 \pm 0.5		
22-S-299	Hole 347 Reg 104	93.6	1.57 \pm 0.28	1.61 \pm 0.25	1.07 \pm 0.21	28.5 \pm 1.8	26.5 \pm 1.7	18.0 \pm 1.1		
22-S-300	Hole 347 Reg 104	88.5	2.65 \pm 0.29	2.31 \pm 0.33	3.08 \pm 0.28	18.0 \pm 1.6	18.3 \pm 1.7	13.2 \pm 1.2		
*22-S-300	Hole 347 Reg 104	88.0	2.65 \pm 0.29	2.31 \pm 0.33	3.87 \pm 0.14	18.0 \pm 1.6	18.3 \pm 1.7	16.3 \pm 0.5		
*22-S-300	Hole 347 Reg 104	88.0	2.65 \pm 0.29	2.31 \pm 0.33	2.99 \pm 0.16	18.0 \pm 1.6	18.3 \pm 1.7	13.4 \pm 0.7		
22-S-301	Hole 347 Reg 104	93.5	1.67 \pm 0.26	1.26 \pm 0.27	0.92 \pm 0.19	35.3 \pm 2.0	31.2 \pm 1.9	22.7 \pm 1.2		
*22-S-437	275L 1+85	73.5	BDL	0.95 \pm 0.19	0.94 \pm 0.03	14.8 \pm 1.1	13.8 \pm 1.1	17.6 \pm 0.2		
*22-S-457	185L 1+85	75.1	1.21 \pm 0.17	0.95 \pm 0.20	0.92 \pm 0.05	15.1 \pm 1.1	14.3 \pm 1.1	16.2 \pm 0.4		
*22-S-504	155L 1+75	91.3	1.17 \pm 0.31	0.97 \pm 0.40	1.12 \pm 0.06	15.8 \pm 1.6	16.7 \pm 2.1	17.4 \pm 0.5		
*22-S-857	5R 0+15	81.4	1.60 \pm 0.31	0.92 \pm 0.24	1.34 \pm 0.16	12.7 \pm 1.6	14.4 \pm 1.1	17.4 \pm 1.2		
Ave		82.7	1.78	2.12	1.99	21.8	18.8	17.9		
Std dev		5.6	1.12	1.67	1.17	4.9	5.4	3.6		
Max		93.6	5.63	5.85	6.52	35.3	31.2	23.6		
Min		72.0	0.20	0.92	0.59	12.7	13.8	9.8		
No of Samples		41	32	13	35	36	13	39		

TABLE 11 (Cont'd)

Sample No.	Sample Location	Z Wt	Th-232 (911 keV)			K-40 (1460 keV)		
			--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
			pCi/g $\pm \sigma$			pCi/g $\pm \sigma$		
Backfill and Top Soil								
*22-SB-069	backfill #1	91.1	0.23 \pm 0.12	NA	0.40 \pm 0.09	1.4 \pm 0.7	NA	23.8 \pm 0.5
*22-SB-070	backfill #2	80.1	1.62 \pm 0.31	NA	2.04 \pm 0.09	23.6 \pm 2.0	NA	1.9 \pm 0.4
*22-SB-071	backfill #3	93.5	BDL	NA	0.38 \pm 0.10	2.1 \pm 1.1	NA	BDL
*22-SB-072	backfill #4	91.8	0.33 \pm 0.16	NA	BDL	1.1 \pm 1.0	NA	BDL
*22-SB-073	backfill #4	91.8	0.33 \pm 0.16	NA	BDL	1.1 \pm 1.0	NA	BDL
*22-SB-076	backfill #5	93.1	1.22 \pm 0.25	NA	1.87 \pm 0.07	19.1 \pm 1.7	NA	17.6 \pm 0.4
*22-SB-851	backfill #3	92.0	BDL	0.30 \pm 0.11	0.29 \pm 0.04	2.1 \pm 1.2	NA	BDL
*22-SB-928	top soil	80.5	0.69 \pm 0.26	0.65 \pm 0.18	1.41 \pm 0.12	1.4 \pm 0.6	0.5 \pm 0.5	BDL
Avc		88.4	0.64	0.47	0.99	6.3	9.4	14.6
Std dev		6.6	0.37	0.17	0.67	7.5	8.5	9.4
Max		93.5	1.22	0.65	1.87	19.1	17.9	24.4
Min		76.0	0.33	0.30	0.29	1.1	0.9	1.9
No. of Samples		7	4	2	4	7	2	3
Miscellaneous Samples								
*22-2-001	105 wood	NA	NA	NA	BDL	NA	NA	BDL
*22-2-007	105 brick	NA	BDL	NA	BDL	BDL	NA	BDL
*22-2-008	105 insulation	NA	1.22 \pm 0.38	NA	1.28 \pm 0.16	5.4 \pm 1.9	NA	8.9 \pm 0.6
*22-2-015	105 chimney tile	96.4	1.44 \pm 0.25	NA	1.93 \pm 0.16	5.4 \pm 1.9	NA	9.6 \pm 0.5
*22-2-015	105 chimney tile	96.4	1.44 \pm 0.25	NA	2.35 \pm 0.09	20.1 \pm 1.5	NA	20.8 \pm 0.5
*22-2-017	107 chimney tile	99.2	0.25 \pm 0.10	NA	2.42 \pm 0.09	20.1 \pm 1.5	NA	19.5 \pm 0.4
*22-2-017	107 chimney tile	99.2	0.25 \pm 0.10	NA	0.45 \pm 0.13	5.8 \pm 0.6	NA	7.0 \pm 1.0
*22-2-018	107 chimney brick	98.9	0.49 \pm 0.04	NA	0.44 \pm 0.06	5.8 \pm 0.6	NA	5.7 \pm 0.3
*22-2-018	107 chimney brick	98.9	0.49 \pm 0.04	NA	1.29 \pm 0.07	5.6 \pm 0.3	NA	12.0 \pm 0.4
*22-2-020	105 mortar	97.8	0.49 \pm 0.04	NA	1.24 \pm 0.09	5.6 \pm 0.3	NA	11.1 \pm 0.4
*22-2-021	107 chimney brick	99.2	0.31 \pm 0.16	NA	BDL	BDL	NA	17.4 \pm 2.0
*22-2-021	107 chimney brick	99.2	0.31 \pm 0.16	NA	0.85 \pm 0.09	6.2 \pm 0.8	NA	9.2 \pm 0.4
*22-2-022	107 chimney brick	98.4	0.42 \pm 0.06	NA	0.74 \pm 0.07	6.2 \pm 0.8	NA	9.7 \pm 0.3
*22-2-028	sewer sludge	83.5	NA	NA	1.77 \pm 0.15	5.3 \pm 0.4	NA	12.7 \pm 0.8
*22-2-028	sewer sludge	83.5	NA	NA	1.32 \pm 0.08	NA	NA	12.6 \pm 0.5
					1.38 \pm 0.07	NA	NA	14.3 \pm 0.5

TABLE 11 (Cont'd)

Sample No.	Sample Location	% Wt	Th-232 (911 keV)			K-40 (1460 keV)		
			--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
			pCi/g $\pm \sigma$			pCi/g $\pm \sigma$		
*22-Z-054	concrete 105	94.3	BDL	NA	0.91 \pm 0.07	11.9 \pm 2.4	NA	15.4 \pm 0.5
*22-Z-066	concrete 105	93.7	0.66 \pm 0.38	NA	0.84 \pm 0.12	15.7 \pm 1.9	NA	10.1 \pm 0.9
*22-Z-155	ash 15L 0-05	77.2	BDL	BDL	1.47 \pm 0.14	11.4 \pm 1.6	9.1 \pm 2.1	13.210.7
*22-Z-555	ash 15L 0-05	77.2	BDL	BDL	2.10 \pm 0.19	11.4 \pm 1.6	9.1 \pm 2.1	15.8 \pm 0.8
*22-Z-556	ash 15L 0-05	75.3	0.95 \pm 0.33	BDL	1.78 \pm 0.39	12.1 \pm 1.7	11.8 \pm 2.4	14.5 \pm 1.6
*22-Z-558	ash 15L 0-05	75.8	0.90 \pm 0.31	0.80 \pm 0.47	1.3810.19	10.7 \pm 1.4	7.9 \pm 2.2	12.8 \pm 0.9
22-Z-625	glass 19L 0-40		BDL	NA	NA	BDL	NA	NA
Ave		91.3	0.74		1.37	9.7	9.5	12.6
Std dev		9.2	0.43		0.57	4.9	1.4	3.8
Max		99.2	1.44		2.42	20.1	11.8	20.8
Min		75.3	0.25		0.44	5.3	7.9	5.7
No of Samples		18	14		19	17	4	20
Smears								
*22-Z-004	105 basement floor		NA	NA	BDL	NA	NA	BDL
*22-Z-016	105 kitchen sink		NA	NA	BDL	NA	NA	BDL

*Samples dried and analyzed by the ACL.
 oUncertainty in the counting statistics.
 NA = Data Not Available.
 BDL = Below Detectable Level.

8.4 Soil Sample Analyses -- Special Areas

- Samples Collected and Analyzed Near Soil Tubes -- Soil samples were taken at various depths adjacent to the soil tubes so that a correlation between the soil tube logging data and the actual ^{226}Ra soil could be established. The results of all the soil tube sample analyses are provided in Appendix D, Tables D.3 and D.4. All analyses were performed using a hyper-pure germanium detector and, in addition to quantification of the ^{226}Ra content of the samples, include an analysis for ^{232}Th and ^{40}K .
- Samples Collected and Analyzed from the Test Plot -- Results of the soil sample analyses performed from the test plot area located in the backyard of the 105/107 Stratford duplex are provided in Appendix D, Tables D.5 and D.6.

9.0 EXPOSURE RATE MEASUREMENTS ON THE RESTORED SITE

During site restoration activities, samples of the backfill were analyzed with the ANL mobile laboratory gamma-ray spectrometry system to ensure that the soil did not contain elevated levels of natural radioactivity or radioactive contamination from some other source. The results of the soil analyses showed that no radioactive contamination was present and that the actual levels (maximum values) of natural radioactivity were very low, 0.3 pCi/g of ^{226}Ra and 0.4 pCi/g ^{232}Th ; and 1.5 pCi/g of ^{40}K (Tables D.11 and D.12). The topsoil had higher levels of natural radioactivity (1 pCi/g each ^{226}Ra and ^{232}Th ; 17 pCi/g ^{40}K , Tables 10 and 11). Levels of natural radioactivity vary with soil type and geographical location.

Once all of the backfill activities had been completed and a layer of topsoil applied, a site survey was performed using the PRM-5-3 survey meter connected to a PG-2 sodium iodide detector. The purpose of this survey was to ensure, for completeness, that there were no elevated levels of natural radioactivity or contamination present in the soil. Surveyors walked over the entire site with the face of the PG-2 detector a few centimeters from the ground surface. No areas were identified with elevated levels of radioactivity. Results of the survey are summarized as follows:

- Areas including most of the property that was backfilled and covered with a few inches of topsoil, 1000-1500 cts/min.
- Areas around the edge of the property that required limited remediation and were covered only with topsoil, 2000-2500 cts/min.
- An area in the northwest corner of the property that was backfilled but not covered with topsoil, 500 cts/min.

From the survey data provided above, it is clear that the backfill used contained very low levels of natural radioactivity. The PRM-5-3 data have been left in terms of cts/min because it is only the relative difference between a series of different measurements, compared to the radiation background, which is important.

Exposure rate measurements using a Reuter-Stokes (RSS-111) pressurized ionization chamber were made at 14 locations on the site (Fig. 33). Measurement locations are shown in Fig. 34 and measurement results are provided in Table 12. All of the reported exposure rate measurements represent an average exposure rate over a period of 1-2 hours approximately one meter above grade from a combination of terrestrial and cosmic radiation. The measured exposure rate ranged from 8-11 $\mu\text{R/h}$ with an average of 9 $\mu\text{R/h}$. If a member of the public were to be continuously exposed at this rate, the resulting annual dose equivalent would be about 75 mrem.



FIGURE 34 Final Exposure Rate Measurements Made Onsite with Pressurized Ion Chamber

TABLE 12 Exposure Rate Measurements on the Restored Site Using the RSS-111 Pressurized Ionization Chamber

Location Number ^a	Total Measured Exposure (μ R)	Monitoring Time (hrs)	Measured Exposure Rate (μ R/h)
1	12	1.42	8
2	12	1.30	9
3	16	1.75	9
4	10	1.25	8
5	14	1.57	9
6	14	1.33	11
7	9	1.07	8
8	11	1.30	8
9	19	1.95	10
10	15	1.55	10
11	11	1.18	9
12	12	1.25	10
13	9	1.15	8
14	11	1.13	10
Average	-	-	9

^aRefer to Figure 34 for actual measurement locations.

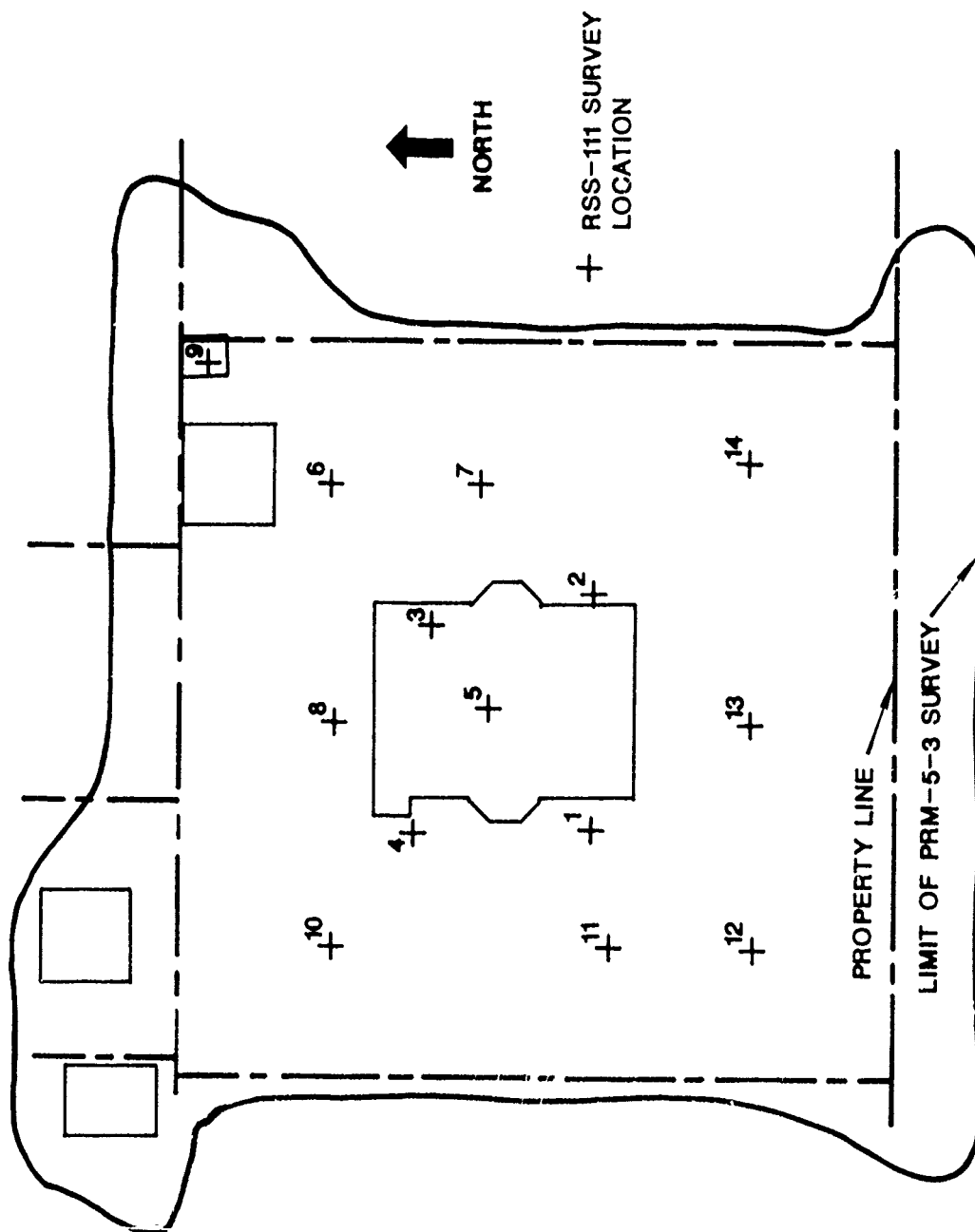


FIGURE 34 Exposure Rate Measurement Locations

An evaluation of the radiation exposures received by members of the general public is provided in Appendix G. Referring to Table 1 in Appendix G, the total annual effective dose equivalent received by a member of the population in the United States from various sources of natural background radiation exposure is estimated to be 300 mrem (NCRP94). There is a certain degree of variability associated with this estimate depending upon the actual geographical location within the United States. The largest contributor to the total effective dose equivalent is from the inhaled radon daughter products (200 mrem) followed by the naturally-occurring radioactivity found within the human body, mostly ^{40}K (40 mrem). Cosmic and terrestrial exposure contribute about the same to the total dose, 27 mrem and 28 mrem respectively. The cosmic radiation exposure component at ground altitudes is due mainly from charged particles, muons and high-speed electrons. At altitudes above 10 km, protons and neutrons become more dominant in their contribution to the total cosmic dose. Naturally-occurring radionuclides widely distributed in soil and rock near ground surface (principally ^{40}K , ^{232}Th series, ^{238}U series) contribute to the terrestrial radiation exposure component. Depending upon the underlying geology, the terrestrial radiation exposure can vary from location to location.

In summary, the exposure rate measurements made on the restored site with the pressurized ion chamber are consistent with the natural radiation exposure rates for this geographical location and are well within the natural variability associated with background radiation.

10.0 CONCLUSION

The initial estimates of ^{226}Ra radioactivity based on the 186 keV gamma-ray were used to determine when remediation was complete. Since the 186 keV gamma ray peak is a combination of the gamma rays from ^{235}U and ^{226}Ra , it was conservatively used to determine that the cleanup criterion had tentatively been achieved pending further laboratory analysis for other radionuclides. The columns of 186 keV data in the table of verification samples (Table D.9) are included for completeness.

For final verification, the gamma-rays from the ^{226}Ra daughter products ^{214}Pb or ^{214}Bi in the aged and dried samples give a more accurate measure of the true ^{226}Ra activity. Table D.9 shows that 5 out of the 336 verification samples had dry weight concentration which slightly exceeded the 5 pCi/g plus background (6.5 pCi/g) criterion. The sample locations are 5L, 0+25; 165L, 0+35; 15R, 0+65; 15L, 1+05; and 165L, 1+05. The highest concentration was 7.17 ± 0.05 pCi/g as measured by the ^{214}Bi 609 keV gamma-ray.

However, the regulations (see Appendix F) are given for ^{226}Ra in land, not oven dried soil. The samples were dried only to make scientific comparisons. The average dry weight percent (Dry Wt%) for the verification samples is 85.0% (15% water). If these dried samples are adjusted for the average moisture content, the maximum concentration in any soil sample (using ^{214}Bi gamma-ray) becomes 6.14 pCi/g. That is, $(7.17 + 0.05) \times 0.85 = 6.14$. These values are below the criterion of 5 pCi/g above the background of 1.5 pCi/g.

Based on the data provided in this report, the soil clean-up criterion for soil contaminated with ^{226}Ra has been satisfied.

11.0 SPECIAL PROBLEMS ENCOUNTERED AND LESSONS LEARNED

- 11.1 In assessing the potential environmental hazard associated with a contaminated site, it would be appropriate to conduct further studies to determine whether the soil contaminant concentration or the total contaminant source term at the site is the more appropriate index.
- 11.2 It may be beneficial to conduct further investigation of established soil clean-up criteria from an exposure pathway analysis perspective to determine the applicability of utilizing a range of clean-up criteria as opposed to a single fixed value. Specifically, the question arises whether the 5 pCi/g criterion at grade level is directly applicable at subsurface depths greater than 4 ft.
- 11.3 Experiences at the Lansdowne site have provided an opportunity to gain further insight into the analytical process of measuring the radium content of soil samples. Use of the 186 keV gamma-ray from ^{226}Ra to quantify the radium content of the soil sample rather than relying upon the daughter product gamma-rays for analysis has been found to be satisfactory. Samples analyzed using the 186 KeV gamma-ray avoid the waiting period necessary for the daughter products to reach equilibrium with the ^{226}Ra . The natural presence of ^{235}U in soil samples introduces an interference in measuring ^{226}Ra since it too emits a gamma-ray of nearly the same energy. The interference produces approximately a 20% overestimation at low radium concentrations (≈ 5 pCi/g) for natural levels of ^{235}U . We have found an acceptable measurement sensitivity in analyzing soil samples of between 500-1000 grams in a Marinelli beaker and counting for 20 minutes using a germanium gamma-ray spectroscopy system. Corrections for the soil moisture content of the samples so that the calculated concentration can be reported on a dry weight basis was found to be approximately 15%.
- 11.4 The job specific basis for requiring workers to wear respiratory protection should be clearly understood by all organizations participating in a D&D project. In some cases, there is no clear-cut distinction on whether respiratory protection should be prescribed and often is a philosophical judgment on the part of the Contractor evaluating the work activity. Based on pre-remediation radiological assessments, standards for respiratory protection should be stipulated in the contract while maintaining some flexibility for changes in levels of protection.
- 11.5 Soil tube measurements using portable survey instrumentation were found to successfully identify and characterize the distribution of soil contamination below grade on the Lansdowne site. The utility of this technique enabled an estimate of the contaminated volume of soil to be excavated and the resources necessary to complete the task. Information about the extent of the subsurface soil contamination is useful during pre-job planning of a D&D project.
- 11.6 Portable survey instrumentation was found to be suitable for identifying soil areas grossly in excess of the clean-up criterion (5 pCi/g). However, the survey

instrumentation exhibited its limitations when contamination was encountered close to the established criterion. In these cases, soil samples had to be collected and analyzed on the gamma-ray spectroscopy system so that a clear determination could be made.

- 11.7 Based on the circumstances at the Lansdowne site, it quickly became obvious that the labor-intensive task of surveying the entire structures of the house to segregate those contaminated items from those not contaminated was a very costly process. The decision to treat an entire structure as radioactively contaminated should be considered in certain situations.

12.0 ACKNOWLEDGMENTS

Dismantlement and Removal of the Lansdowne Radioactive Residence Complex at 105/107 E. Stratford Avenue involved a number of different governmental and non-governmental organizations which deserve to be acknowledged for their excellent cooperation and participation during the course of the project. Mr. Vic Janosik of the U.S. Environmental Protection Agency assisted with the coordination of many of the off-site interfaces that were required, including the concerns of the local neighborhood. We are well aware of the political and environmental sensitivities which had to be addressed by Mr. Janosik for the project to reach its conclusion. Argonne personnel worked closely with the U.S. Army Corps of Engineers onsite project engineer, Mr. Walt Wickboldt, by providing guidance in matters of radiological health and safety. We appreciate Mr. Wickboldt's responsiveness to our concerns and the dedication and professionalism that he showed throughout the course of the project. We also wish to acknowledge the support provided to Argonne personnel by Mr. Ray Huston, project manager, Chem-Nuclear Systems, Inc., the prime site contractor during dismantlement, removal and remediation activities at the Lansdowne site. On many occasions Mr. Huston provided the necessary manpower so that Argonne personnel could more expeditiously complete its tasks, especially when assistance was required in driving the conduit into the ground for estimating the extent of the subsurface contamination. Mr. Huston's patience and understanding during the resolve of many different issues and the cooperation of his staff was also very much appreciated.

We also wish to acknowledge and thank all of the Argonne personnel who participated in the project during its ten month duration. Thanks is also given to Ms. Colette Gombash of the Energy, Environmental, and Biological Research Division for the careful typing of this report, to Mr. David Reilly for preparing many of the drawings included in this report, and to Mr. Robert Heinrich and others of the Analytical Chemistry Division for the various analyses conducted on the many samples submitted for re-analysis.

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40 CFR Part 192, *Health and Environmental Protection Standards for Uranium Mill Tailings*.

APPENDIX A

APPENDIX A

HISTORICAL PERSPECTIVE OF EVENTS

- 1896
 - H. Becquerel discovers natural radioactivity by observing scintillations produced by alpha/beta particles from uranium in luminescent substances.
- 1898
 - M. Curie establishes the existence of a new element while working with a sample of pitchblende ore which she later named radium.
- 1902
 - Atomic mass of radium determined to be 226 from the first 0.1 gram of the element extracted and concentrated
 - With a grant from the French Academy of Sciences, factory-scale production of radium was initiated in Paris using the radium extraction techniques of M. Curie.
- 1903
 - Austrian government places an embargo on the export of ore and residue from the St. Joachimsthal Mine after recognizing the potential value of radium.
- 1906
 - Commercial radium production was attempted by Stephen Lockwood but his Rare Metal Reduction Company lasted only two years because the radium recovery efficiency was poor and there was little demand for the uranium/vanadium by-products.
- 1906-1910
 - Radium extraction and refining facilities were built throughout Europe.
- 1910
 - Joseph Flannery, a former Pittsburgh undertaker, organized the Standard Chemical Company to extract radium from western (U.S.) carnotite ores.
- 1910
 - Dicran Kabakjian obtains Ph.D. in Physics from the University of Pennsylvania, and continues research on campus at the Randall Morgan Physics Laboratory seeking a solution to the problem of a radium shortage.
 - Current market price for 1 gram radium -- \$120,000.
- 1913
 - Radium production was well underway at the Standard Chemical Company's plant in Canonsburg, Pennsylvania, and at its refining laboratory near Pittsburgh. Standard Chemical Company leader in the American radium industry.
 - Kabakjian sells a radium refining technique that he has developed to the W.L. Cummings Chemical Company of Lansdowne, Pennsylvania.

- 1913-1915 • Pitchblende deposits discovered in the Haut Katanga District of the Belgian Congo, but wartime pressures for maximum production of copper from the Congo prevented its exploitation.
- 1915 • W.L. Cummings Chemical Company of Lansdowne was refining approximately 3 grams of radium per year (maybe 15% of U.S. market).
- 1921 • Mining of very high grade ore from the Haut Katanga District of the Belgian Congo began. Ore was shipped to a radium extraction facility in Oolen, near Antwerp.
- 1922 • Radium production from the Oolen facility forced an immediate and final shutdown of almost all radium extraction facilities in the United States. Approximately 400 tons of United States-mined carnotite ore was required to produce 1 gram of radium while only 10 tons of Katanga ore (pitchblende) was needed to achieve the same amount of radium.
- Two of the largest United States companies involved in radium extraction, Standard Chemical Company of Pittsburgh and the Radium Company of Colorado, sensed a loss of competitiveness with the Oolen facility and decided to become agents for the sale of the Belgian radium in the United States.
- W.L. Cummings Chemical Company ceases operations.
- 1924 • With the rise in the world-wide production of radium, market value drops from a high of \$180,000 in 1915 to about \$70,000 per gram in 1924.
- Kabakjian decides to open a family business refining radium in the basement of his house on Stratford Avenue in Lansdowne, just a short distance from the former W.L. Cummings Chemical Company.
- Using specialized chemical techniques, the radium that Kabakjian purchased was refined and enriched through a repetitive fractional crystallization process.
- 1924-1944 • Kabakjian and his family manage to operate a successful radium needle production facility within their house at Stratford Avenue. During this period, thousands of radium needles were produced and sold through the world.
- 1934 • Marie Curie dies of leukemia.
- 1945 • After a few years of failing health, Dicran Kabakjian dies at age 70 of pulmonary fibrosis, attributed to the chronic inhalation of acid vapor.
- 1949 • Mrs. Kabakjian sells her half of the duplex to a young family.

- 1961 • The duplex is once again sold.
- 1963 • Pennsylvania Department of Health and the U.S. Public Health Service enter into a formal agreement to decontaminate the duplex.
- 1964 • The family occupying the house is relocated during the four month decontamination project.
- After the four month decontamination project, the house was declared safe and the owners allowed to return.
- 1983 • USEPA identifies the Lansdowne house as the only radioactive site within its jurisdiction that might qualify for its Superfund toxic waste cleanup program.
- 1984 • On behalf of the USEPA, Argonne National Laboratory makes a preliminary radiological assessment of the property on Stratford Avenue.
- 1988-1989 • Based on the findings of the preliminary radiological assessment, the house is dismantled and disposed of as radioactive waste. Contaminated soil is removed from the site. Entire site is restored for unrestricted use.

APPENDIX B

APPENDIX B

INSTRUMENT/SITE PHOTOGRAPHS

Appendix B contains photographs of the radiological instruments used by Argonne personnel at various stages during the project. Also included in Appendix B is a group of selected photographs capturing various aspects of project operations.

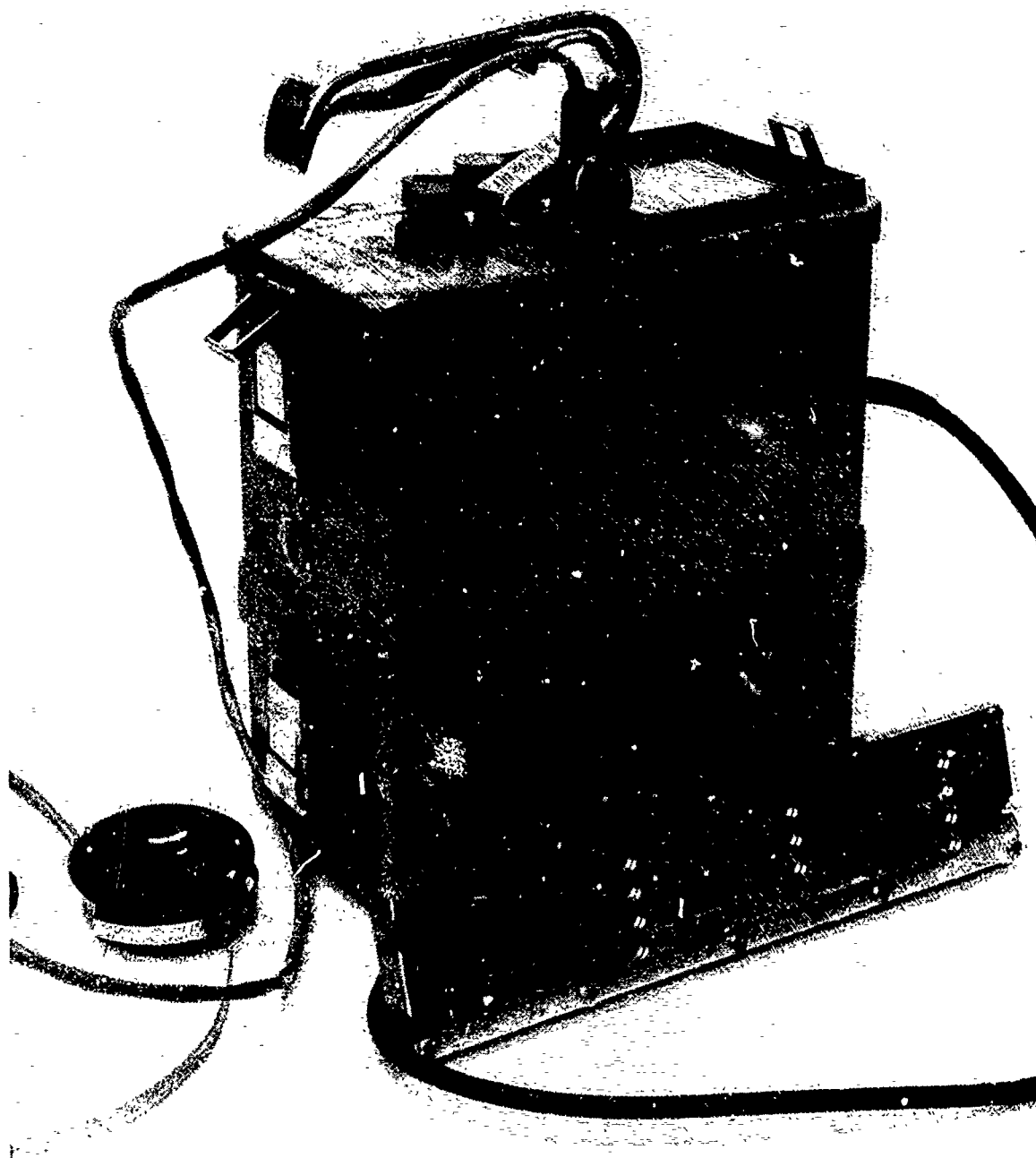


FIGURE B1. PAC-4G-3 with 51 cm² Probe



FIGURE B2. Gas Proportional Counter (Bottom PC-3A, Top PC-5)

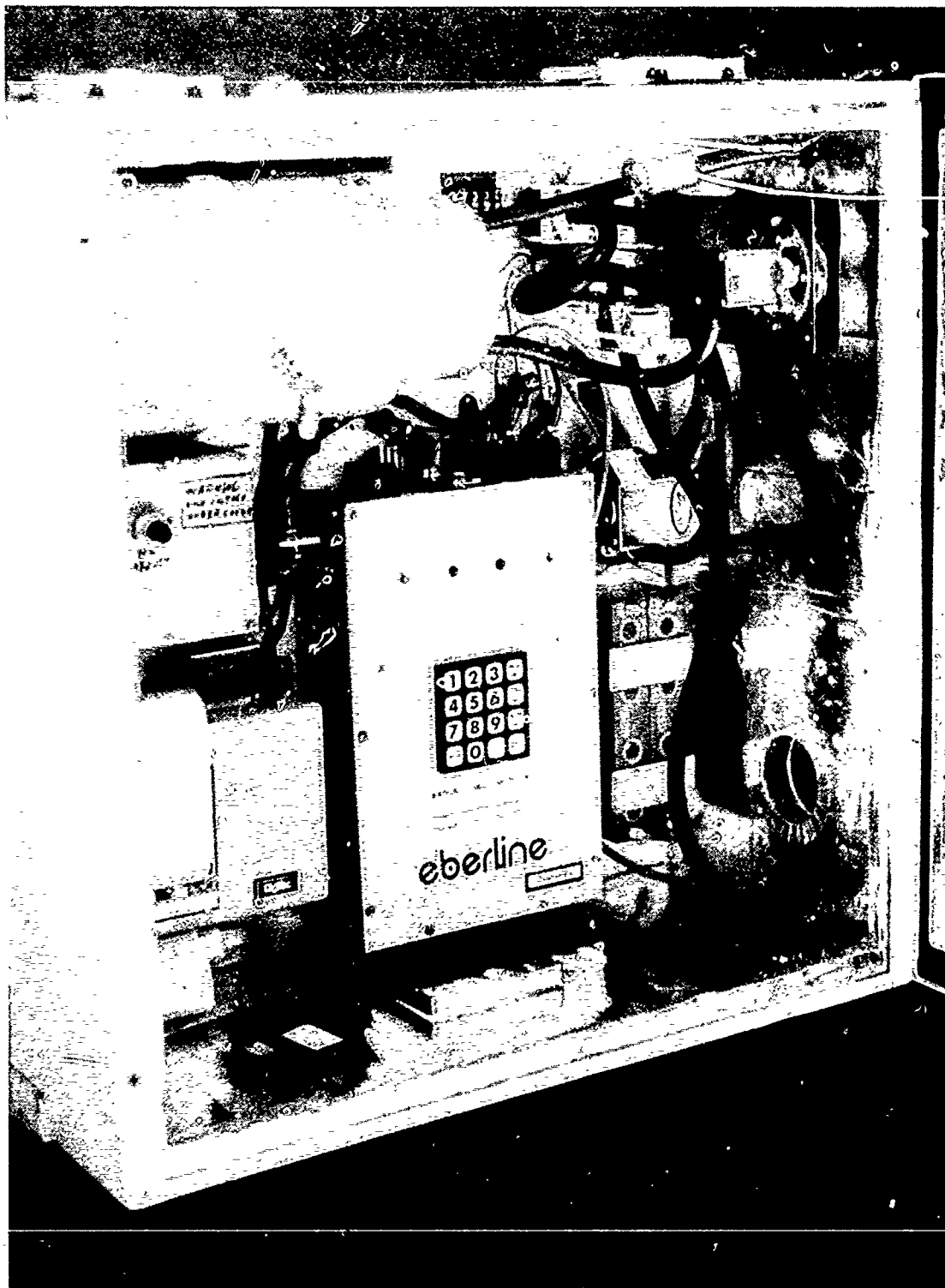


FIGURE B3. Radon Gas Monitor (RGM-2)

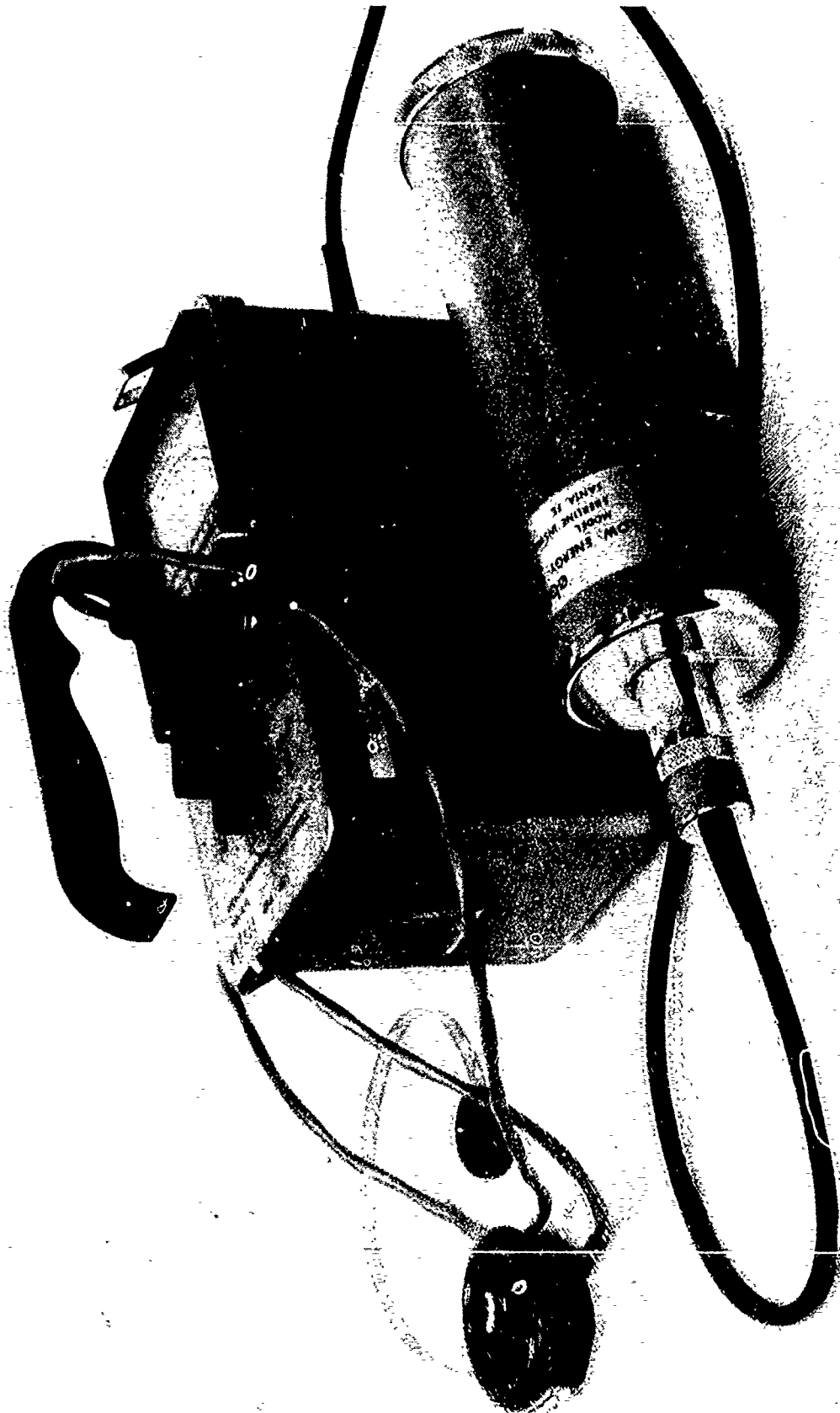


FIGURE B4. PRM-5-3 with PG-2 Detector

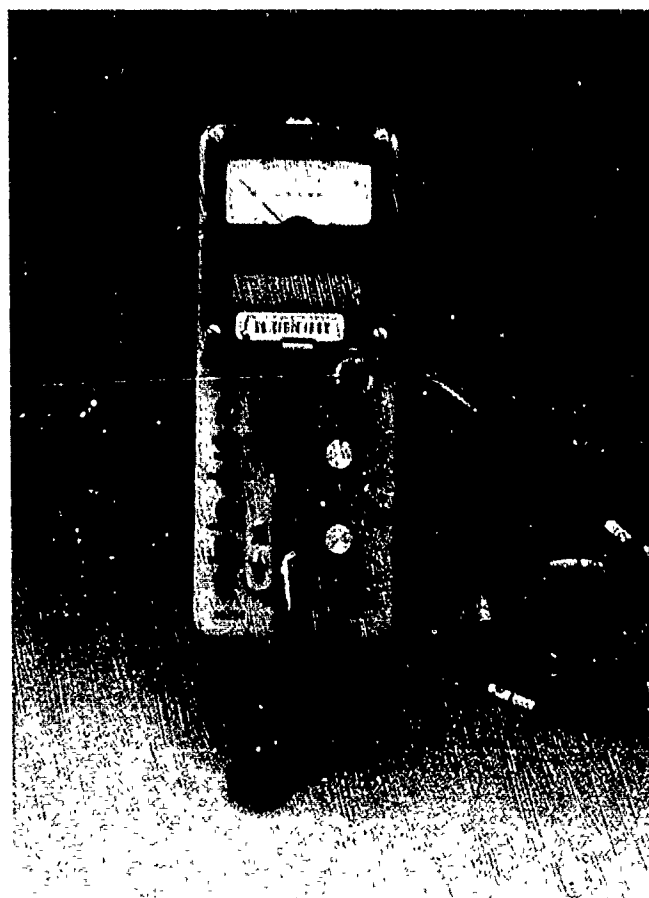


FIGURE B5. Ludlum 2200 with sodium iodide detector



FIGURE B6. ND-6 Portable Multichannel Analyzer



FIGURE B7. Hyper-Pure Germanium (HPGe) Detector

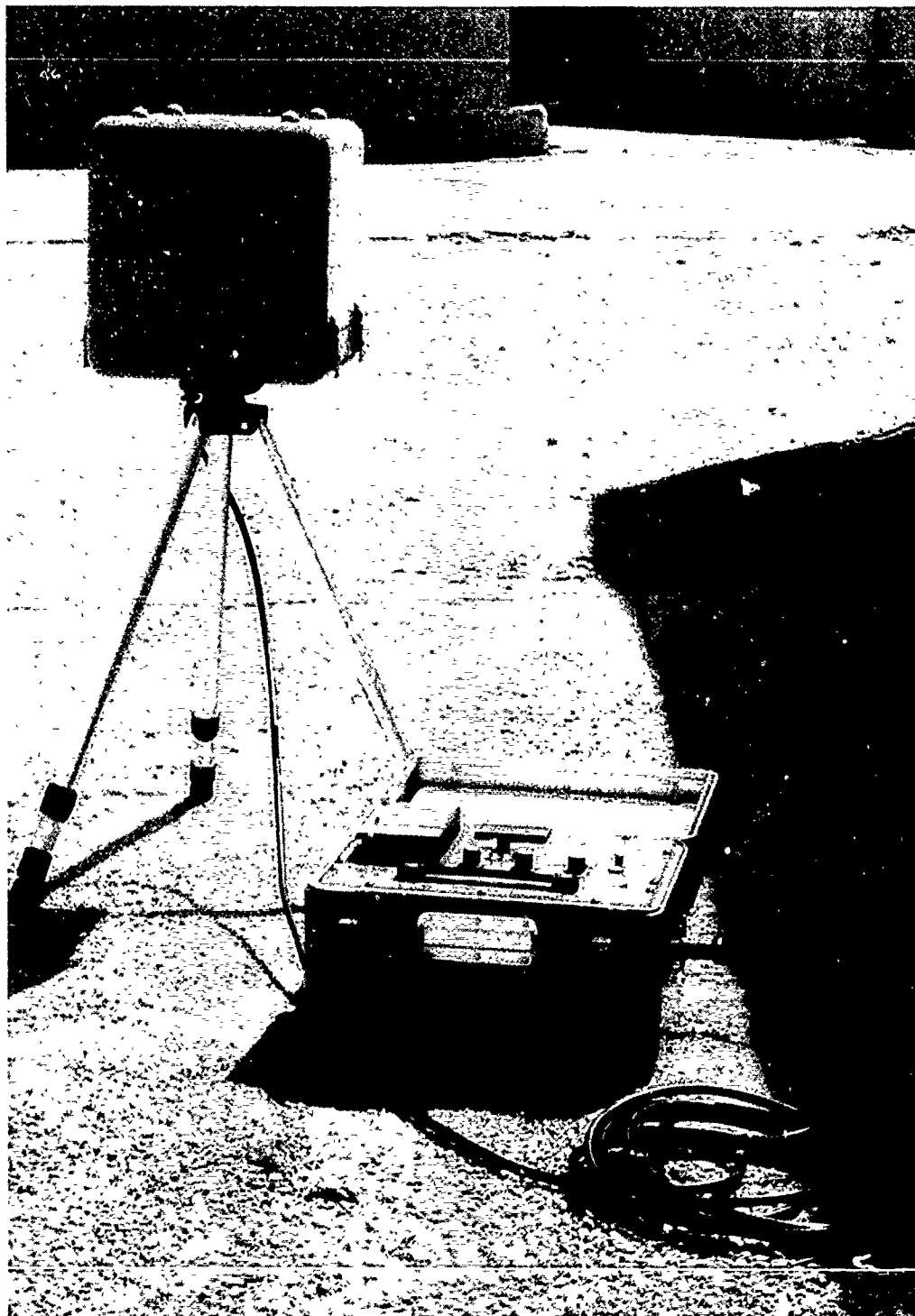


FIGURE B8. Reuter Stokes Model RSS-111

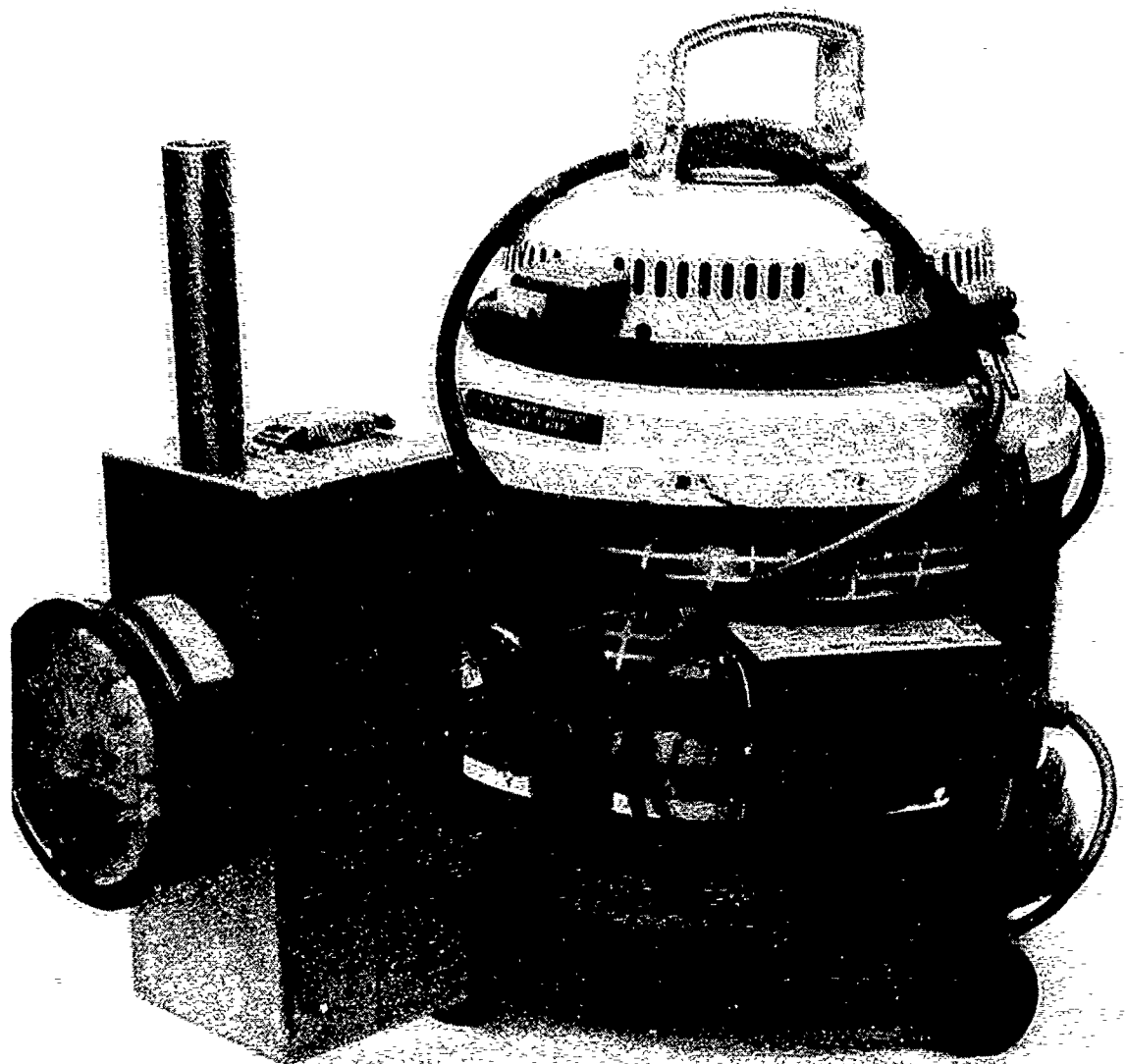


FIGURE B9. Filter Queen Air Sampling System



FIGURE B10. Photograph of Duplex Prior to Remediation Activities



FIGURE B11. Furniture Inside the 107 Duplex



FIGURE B12. Exposure of the Brick Fireplace in the 105 Duplex



FIGURE B13. Worker Making Adjustments to Ventilation Trunk



FIGURE B14. Dismantling Operations Along the Back Porch



FIGURE B15. Dismantling/Surveying Operations in the Upstairs of the Duplex

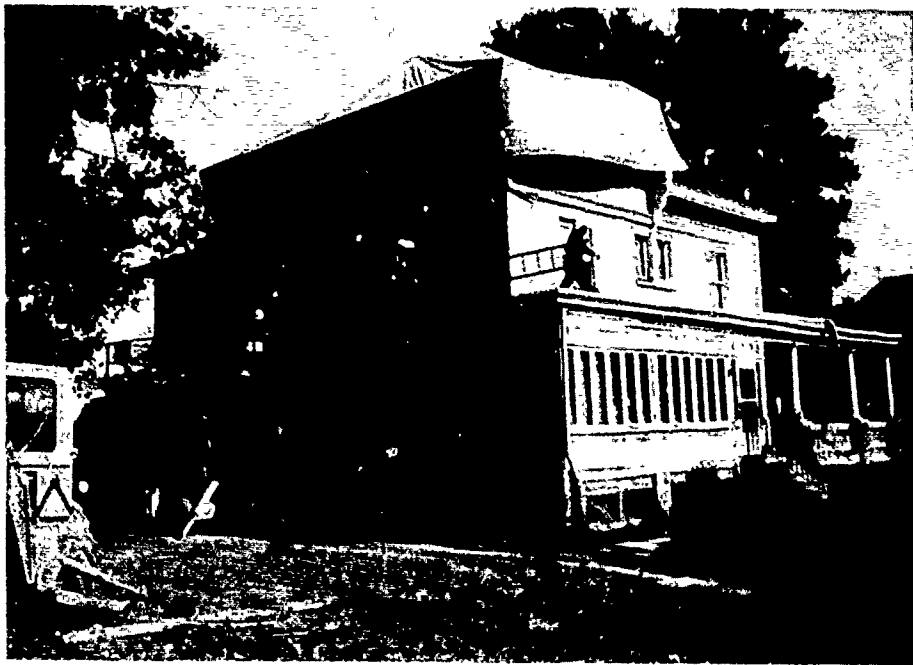


FIGURE B16. Tarpaulin Used to Prevent Release of Contaminants to the Environment



FIGURE B17. Workers Continuing to Dismantle the Duplex



FIGURE B18. Duplex Dismantled to the First Level Flooring



FIGURE B19. Excavation Operations Along the 105 Duplex Driveway



FIGURE B20. Worker Surveying Ground to Determine Extent of Contamination



**FIGURE B21. Overview of Site after Excavation Activities.
Sewer Line Trench Shown in Foreground**



FIGURE B22. Worker Surveying During Excavation Operations



FIGURE B23. Worker Surveying in the Vicinity of the Townshend Garage



FIGURE B24. Worker Packing Contaminated Soil in a Waste Bin

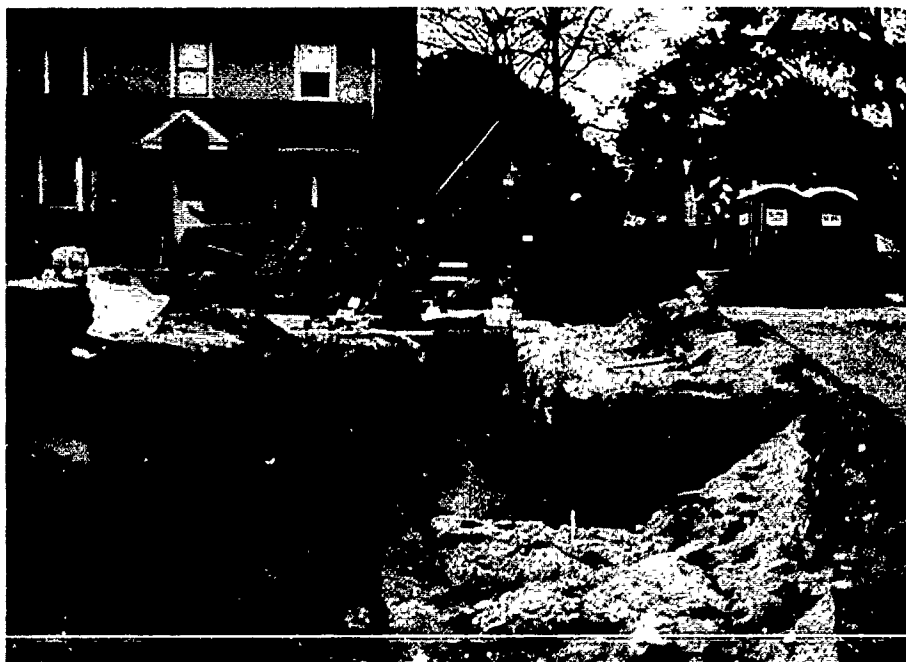


FIGURE B25. Excavation Activities Associated with the Stratford Avenue Sewer Line



FIGURE B26. Workers Packing Waste Bin with Contaminated Soil



FIGURE B27. Loading Waste Bins on Flatbed Truck for Transport to Burial Site

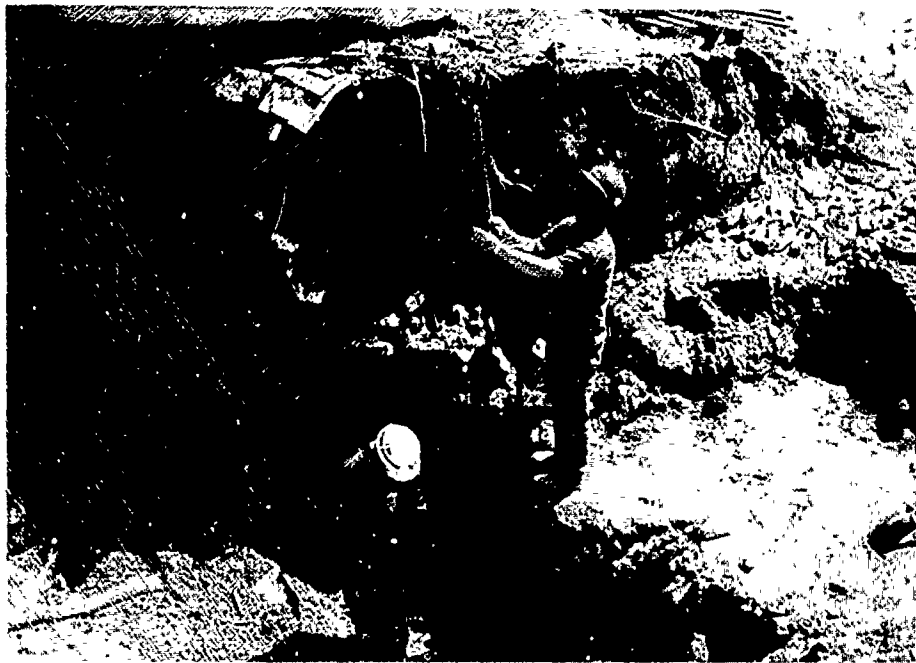


FIGURE B28. Workers Measuring the Large 14 ft x 14 ft Pit

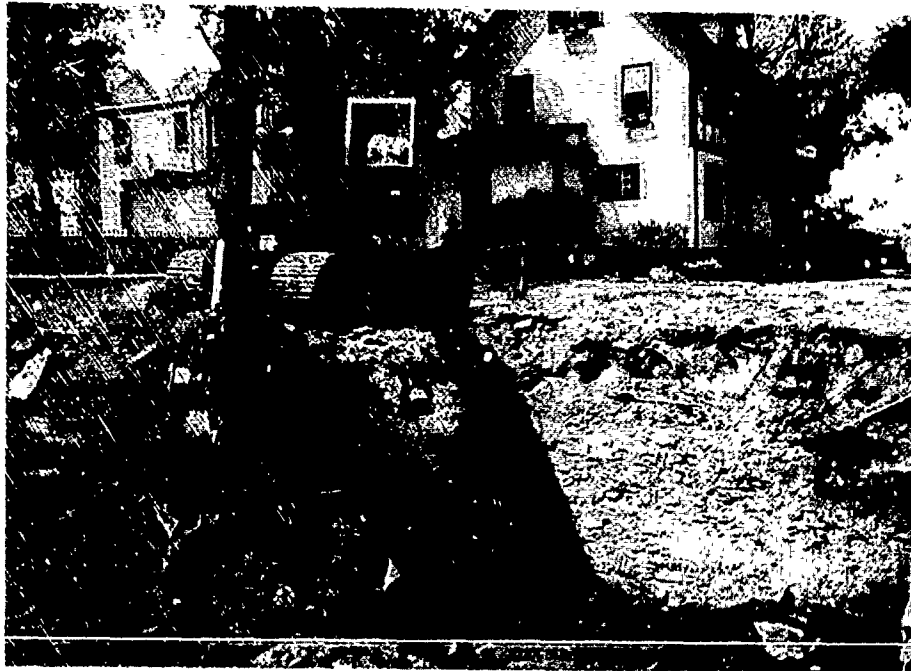


FIGURE B29. Backfilling the Large 14 ft x 14 ft Pit



FIGURE B30. Backfilling the Site With Clean Soil



FIGURE B31. Compacting the Backfill Soil

APPENDIX C

APPENDIX C

SOIL TUBE DATA

Appendix C contains the data from the soil tubes. For ease in locating the tubes and using the data the site and peripheral properties are divided into zones shown in Figure C1. Each zone contains a number of regions. The regions are shown in Figures C2 through C11. In most regions there are four graphs from two to four soil tubes. The graphs are a visual display of the soil tube data. Soil samples taken near some of the soil tubes are presented in Appendix D, Tables D3 and D4. The zones, regions, and hole numbers in Tables D3 and D4 correspond to those presented in this Appendix.

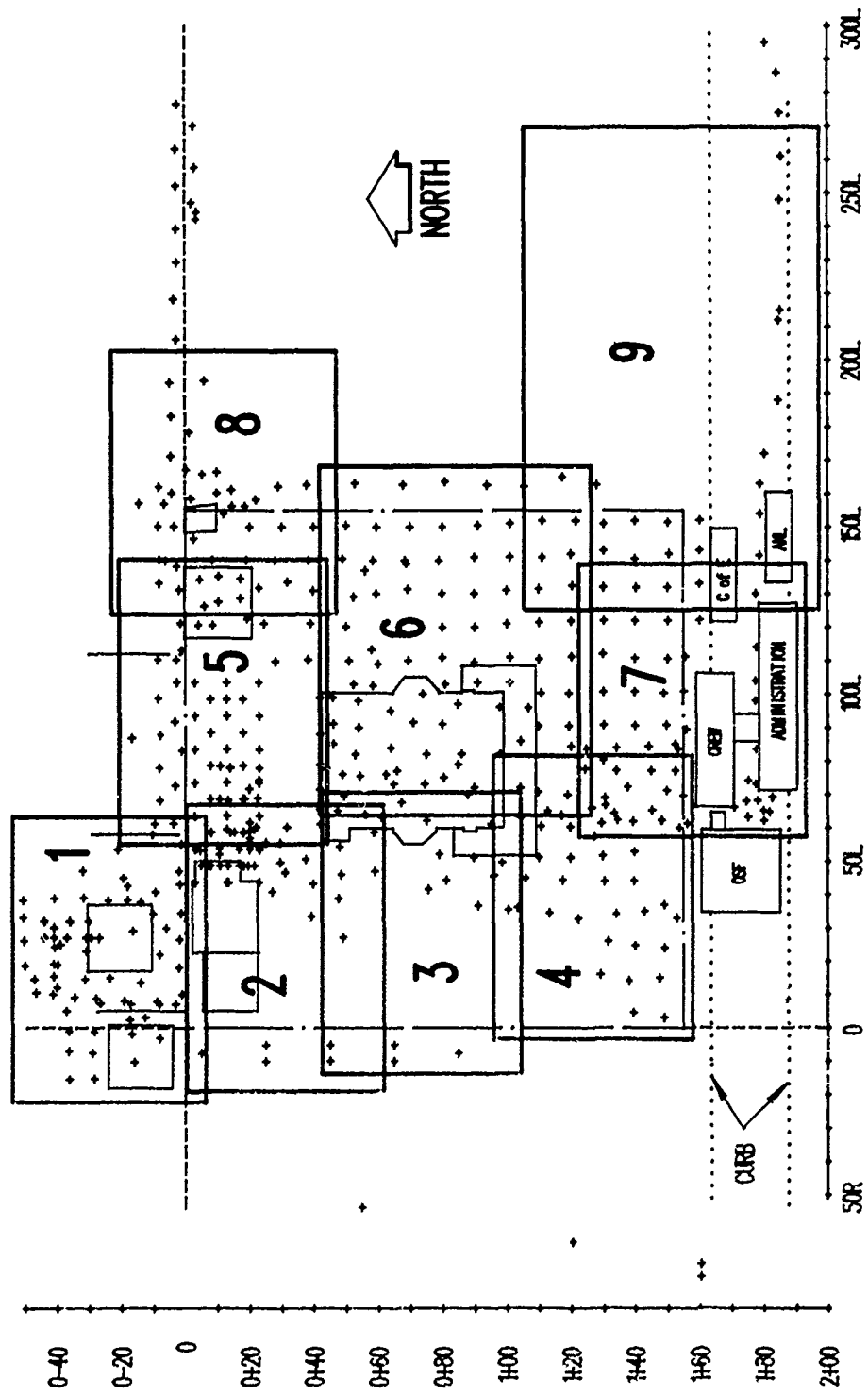


FIGURE C1. Overview of Various Site Zones

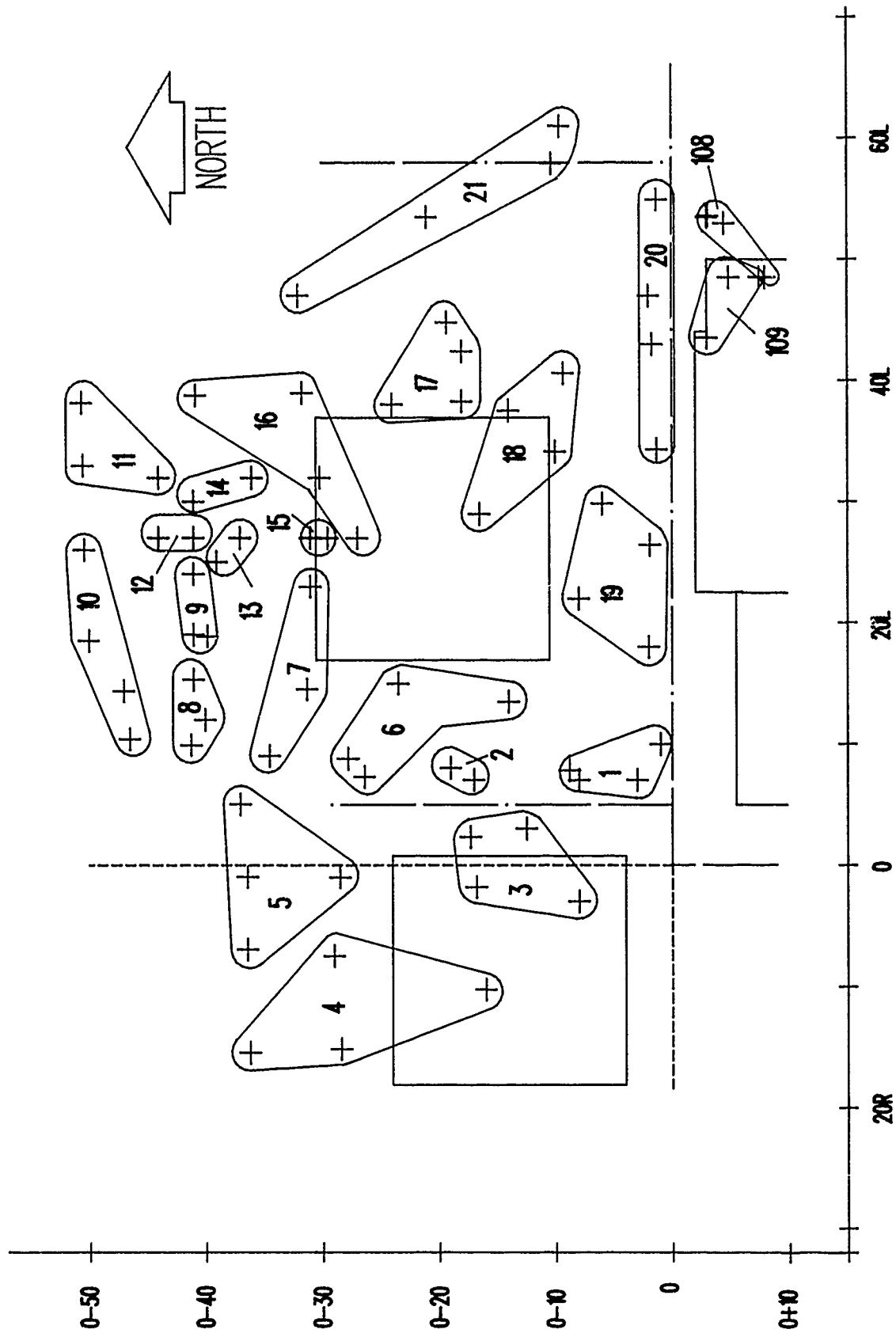


FIGURE C2. Various Regions in Zone 1

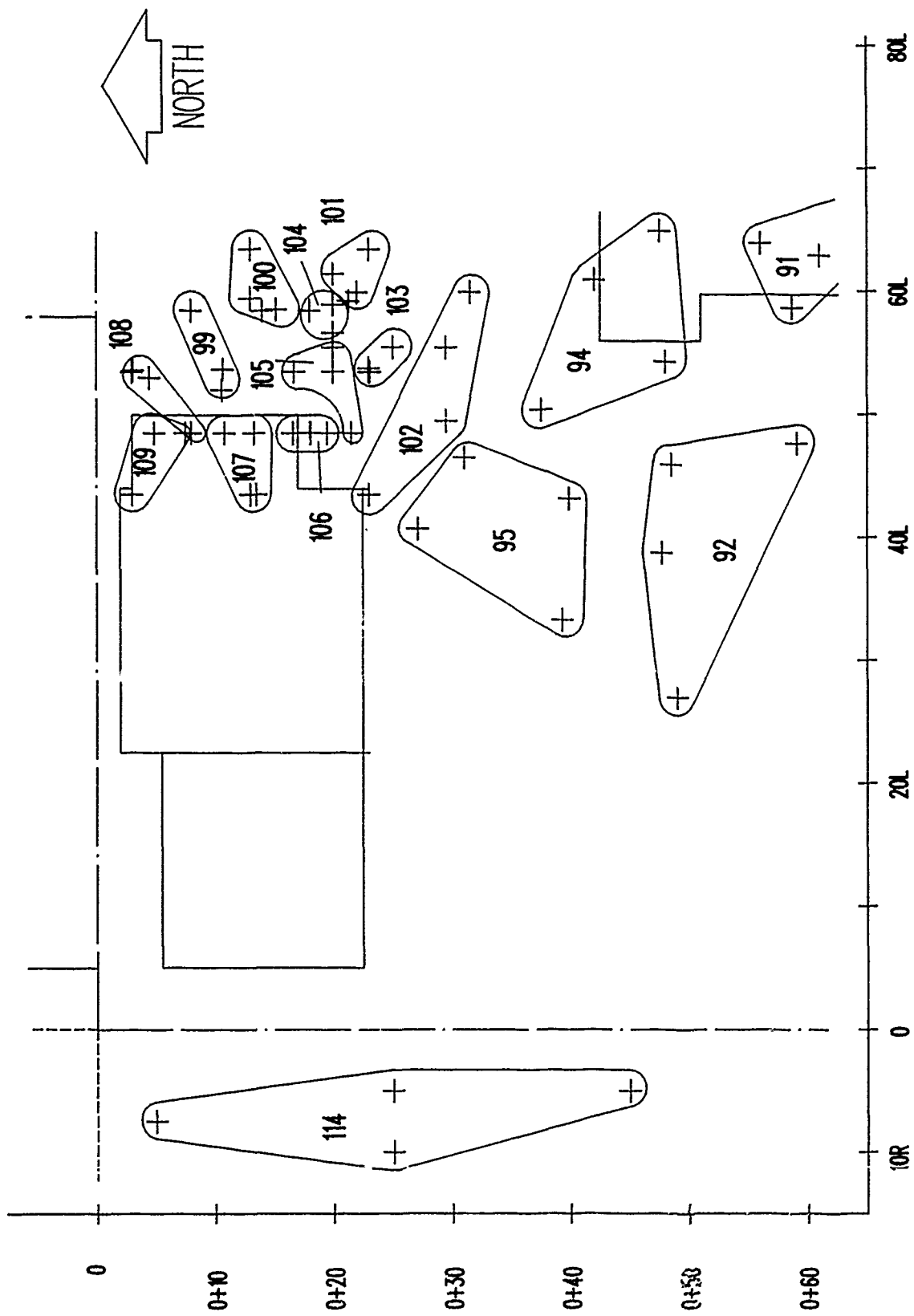


FIGURE C3. Various Regions in Zone 2

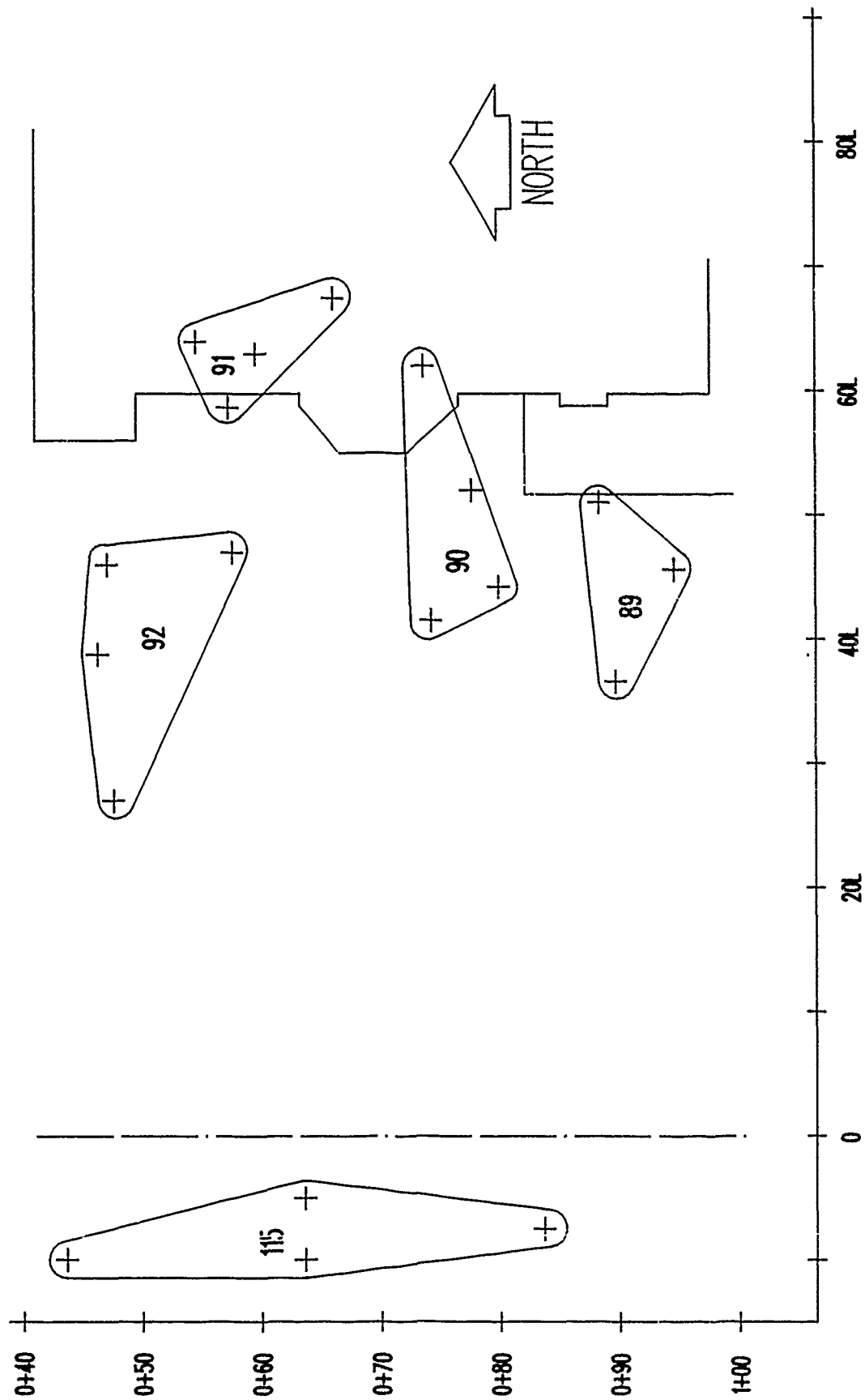


FIGURE C4. Various Regions in Zone 3

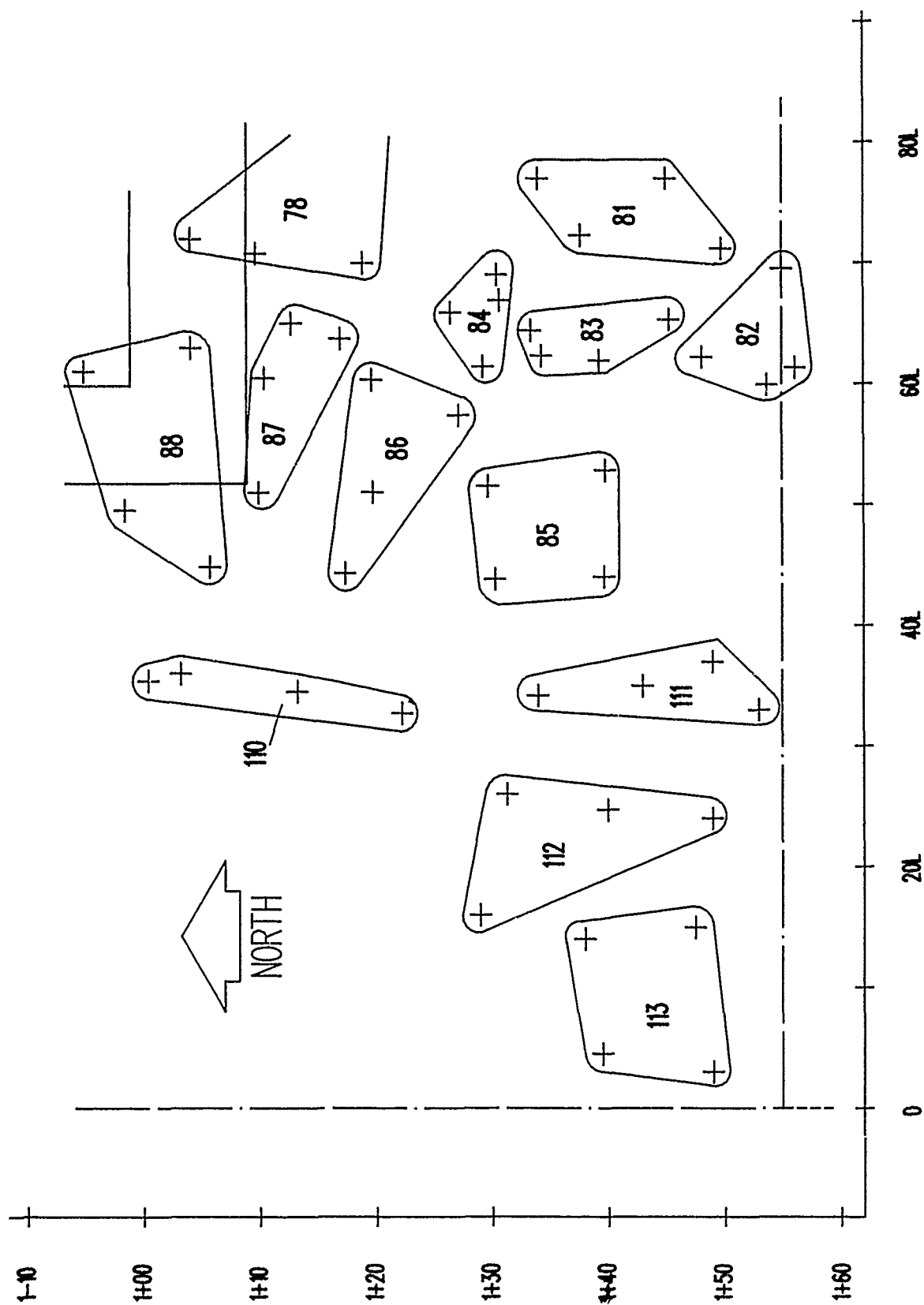


FIGURE C5. Various Regions in Zone 4

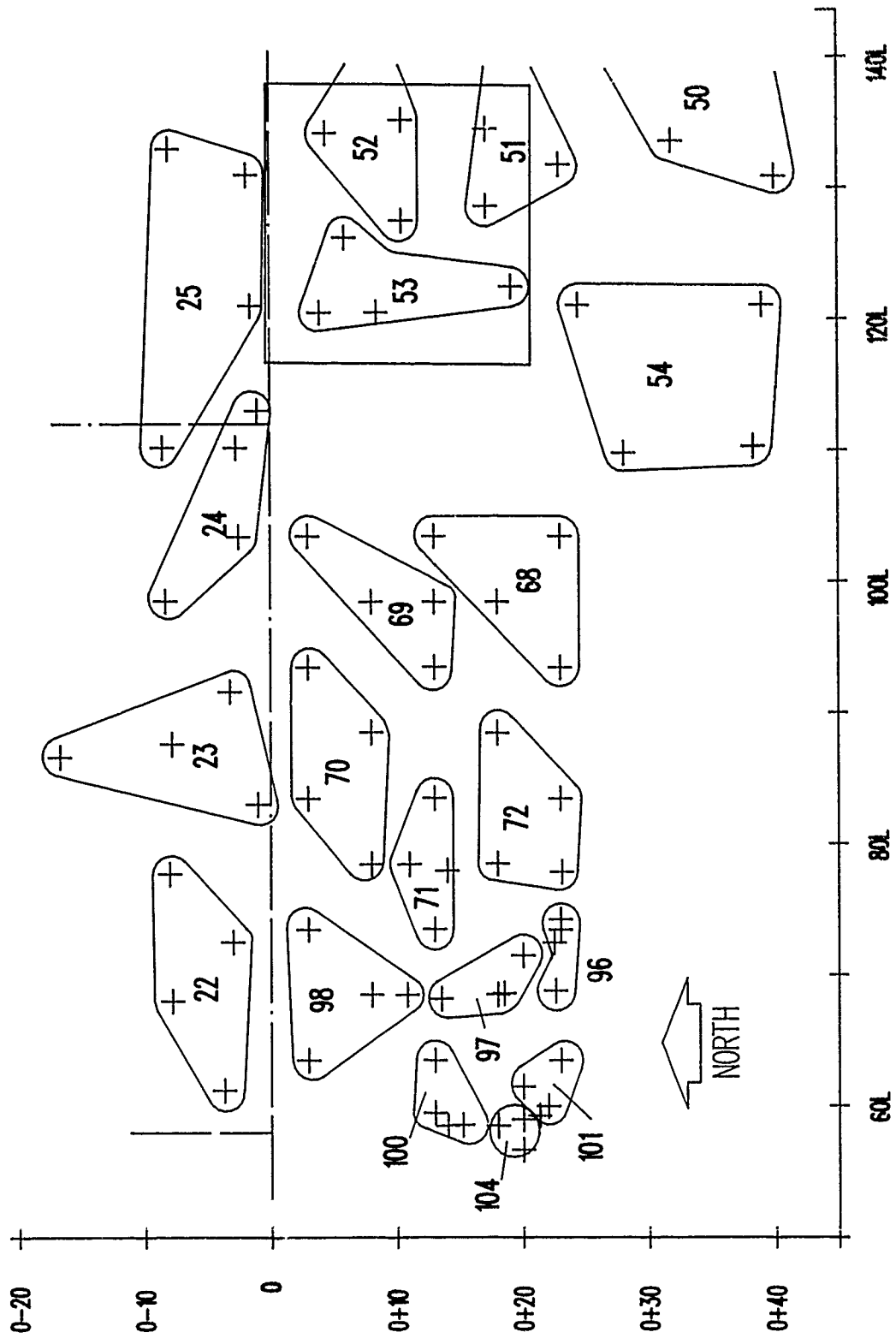


FIGURE C6. Various Regions in Zone 5

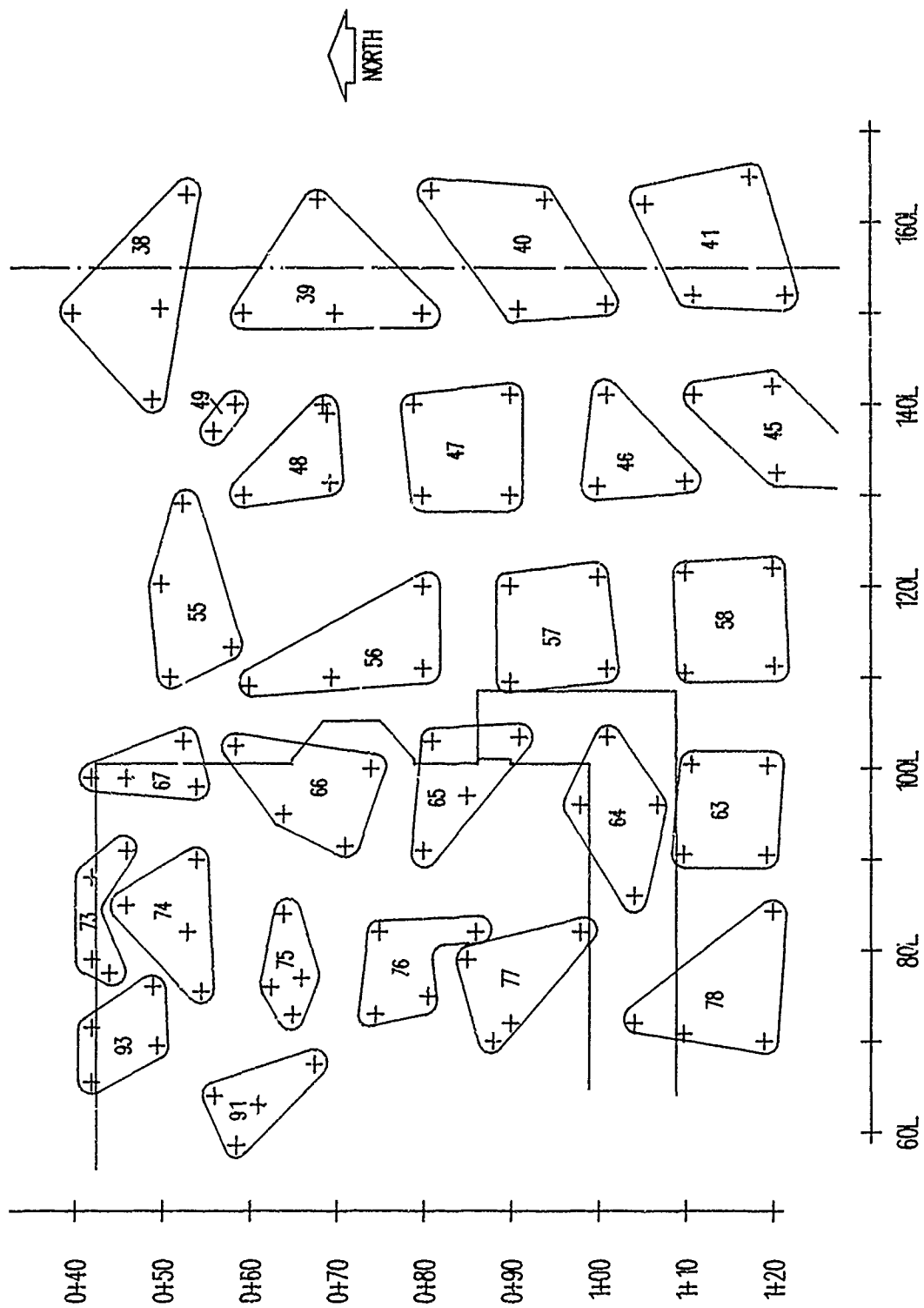


FIGURE C7. Various Regions in Zone 6

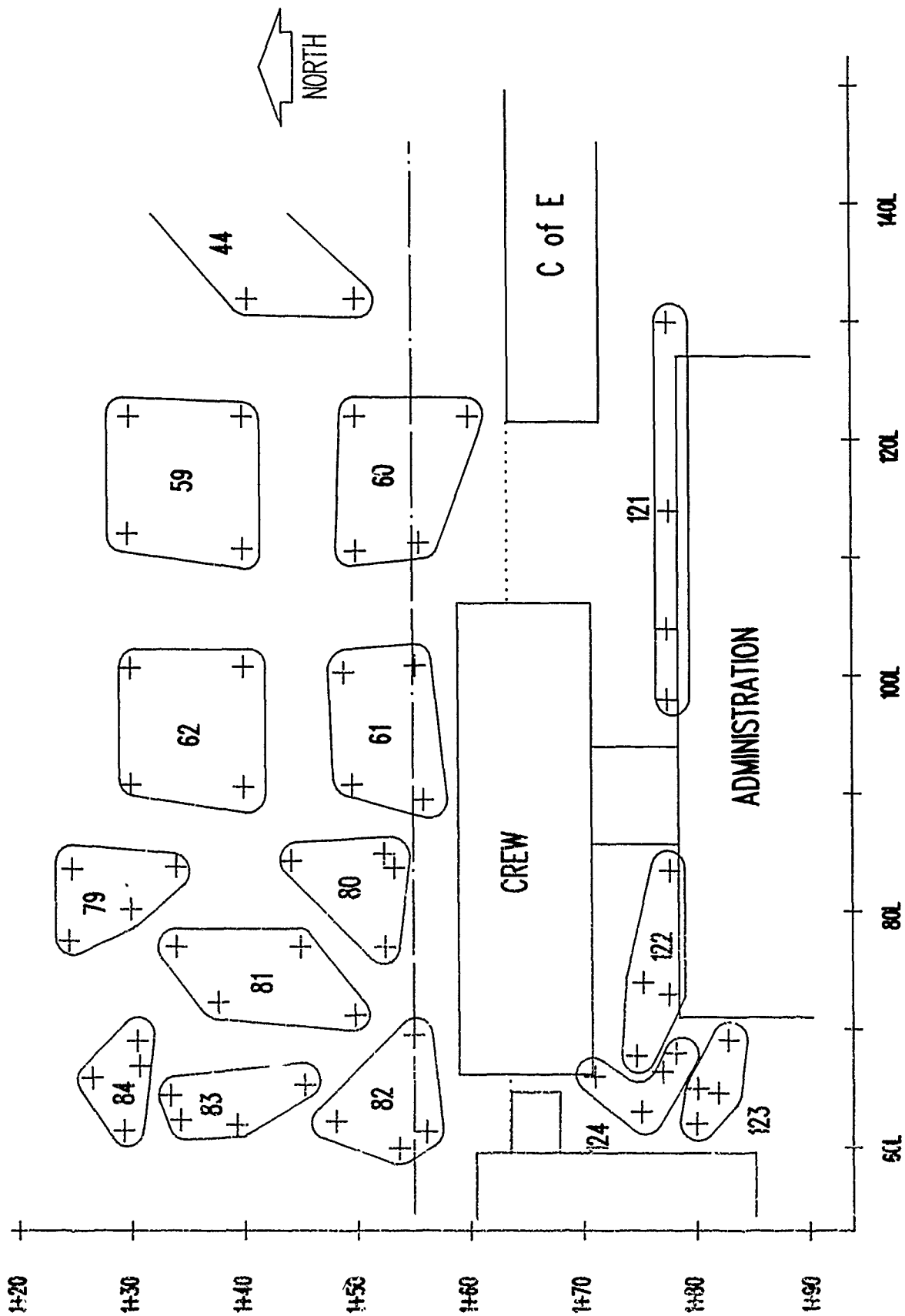


FIGURE C8. Various Regions in Zone 7

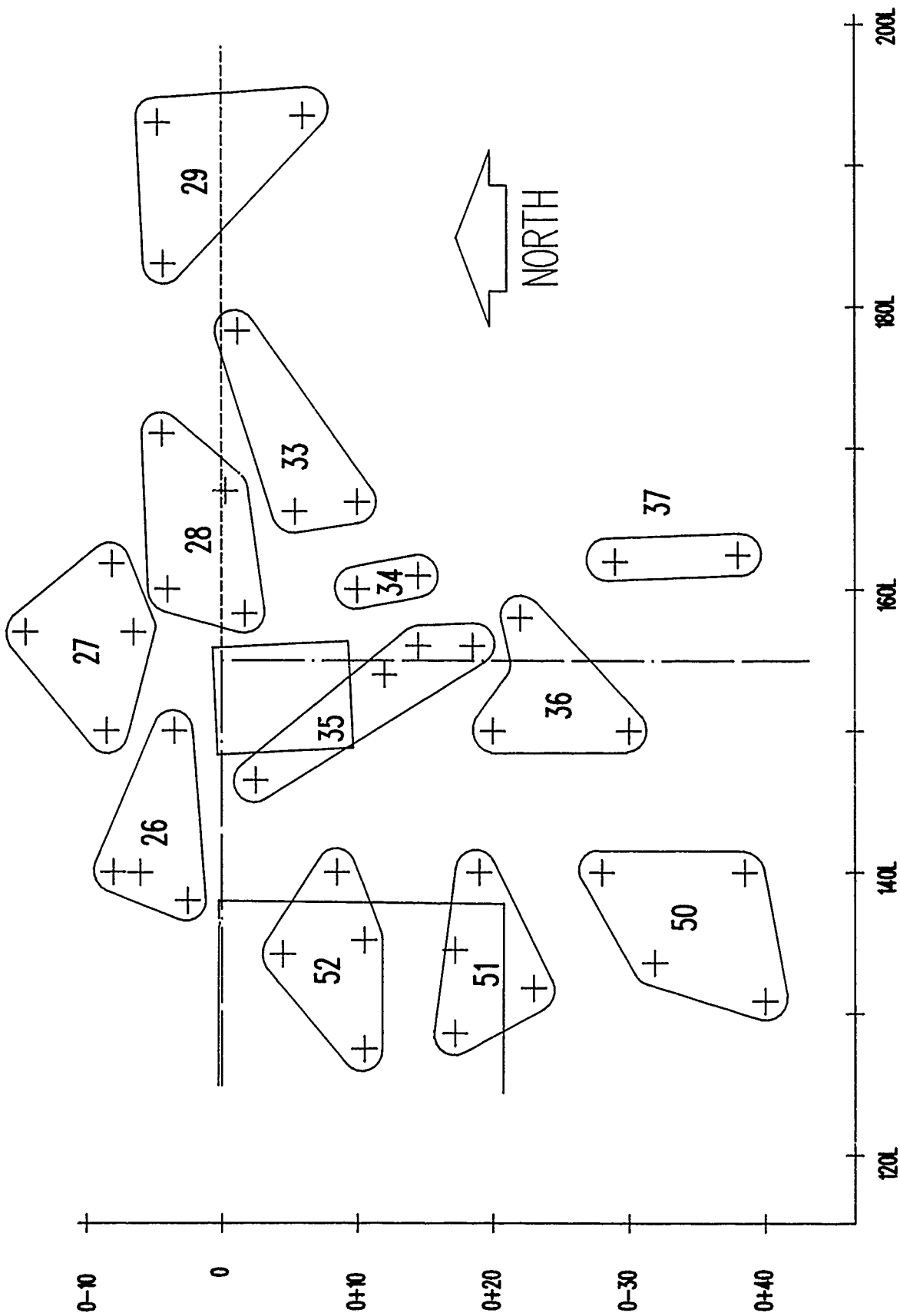


FIGURE C9. Various Regions in Zone 8

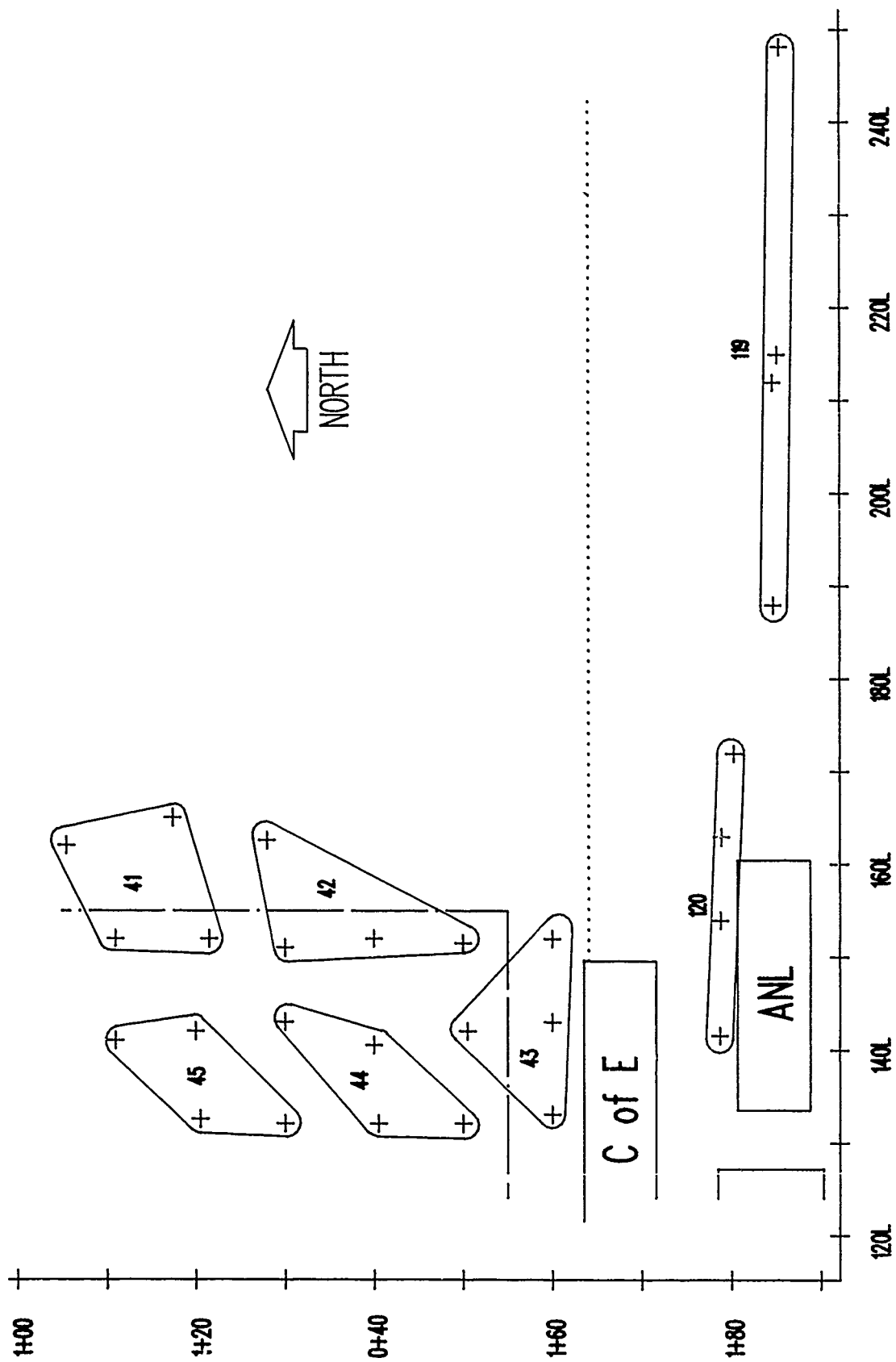


FIGURE C10. Various Regions in Zone 9

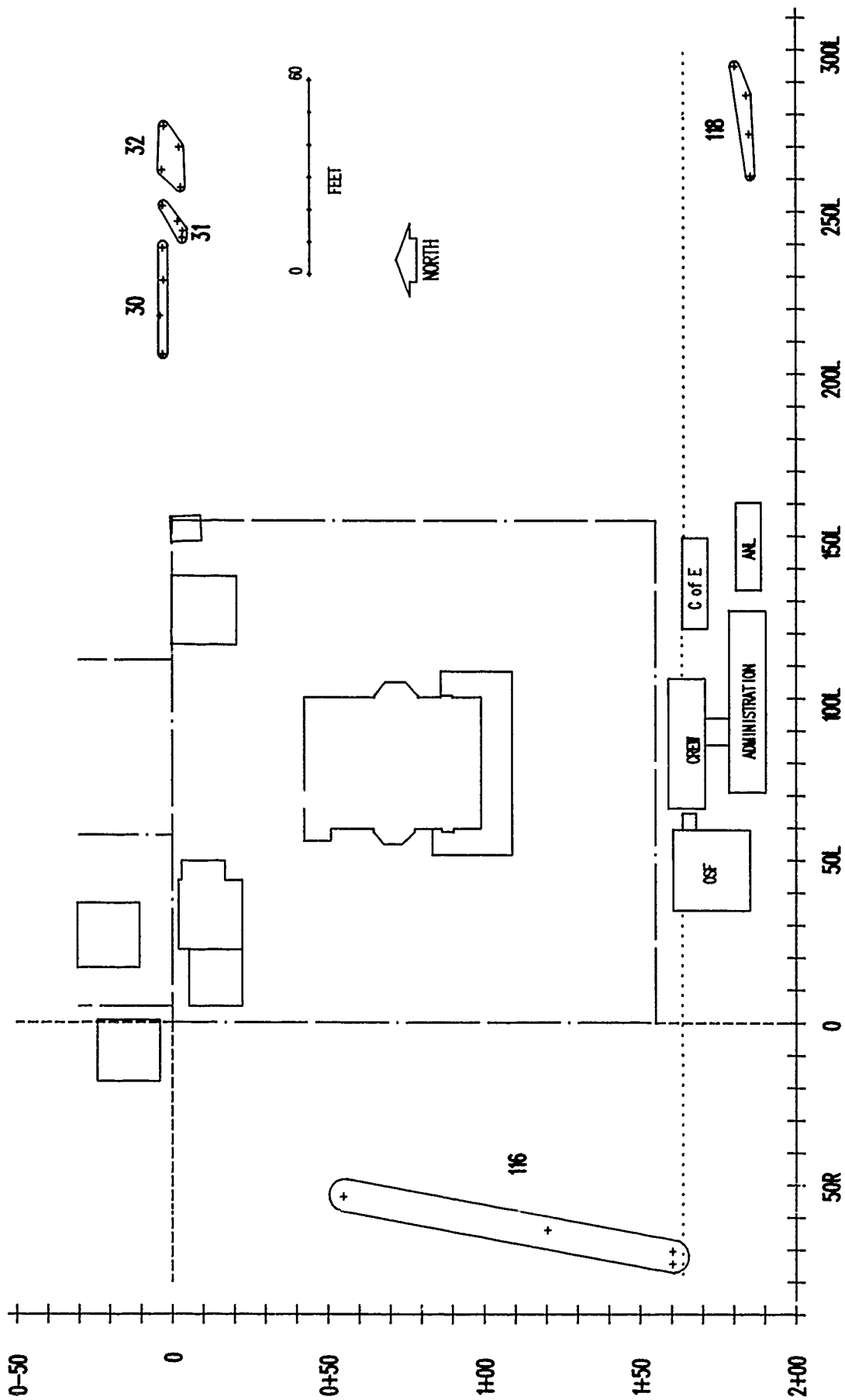


FIGURE C11. Regions Not a Part of Zones 1 through 9

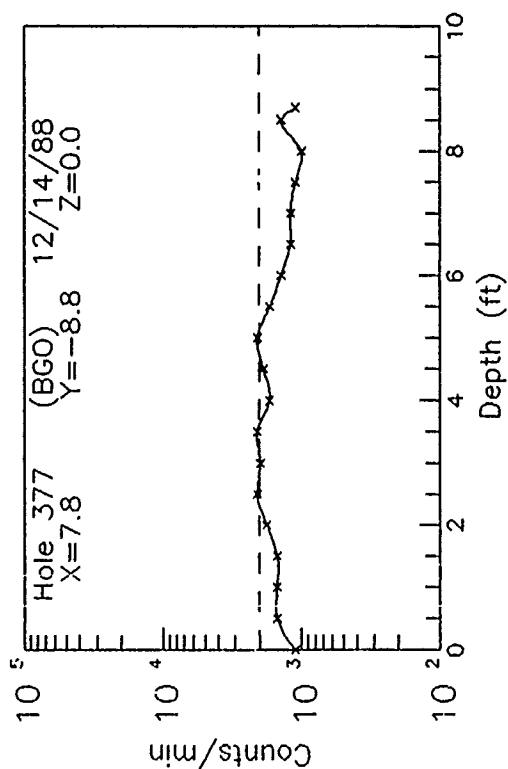
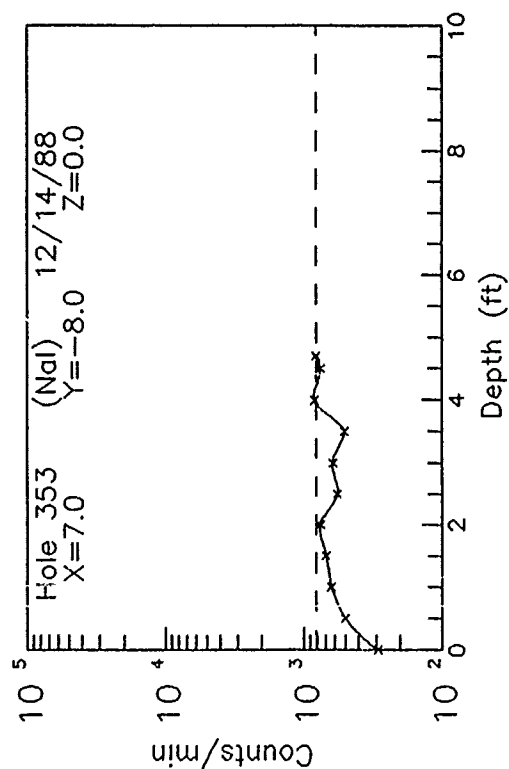
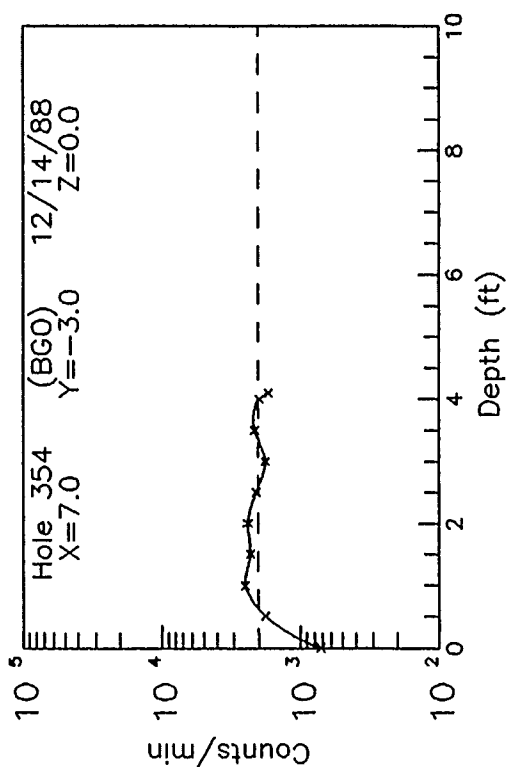
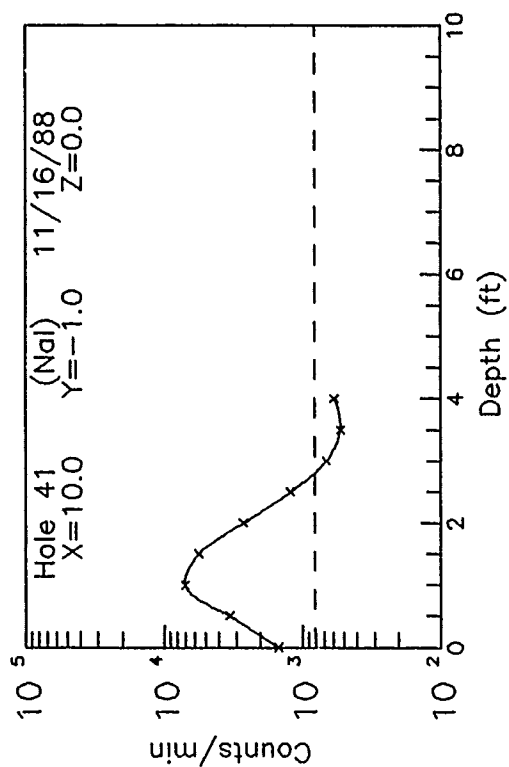


Figure C12. Subsurface Data from 112 Stewart in Map Region 1

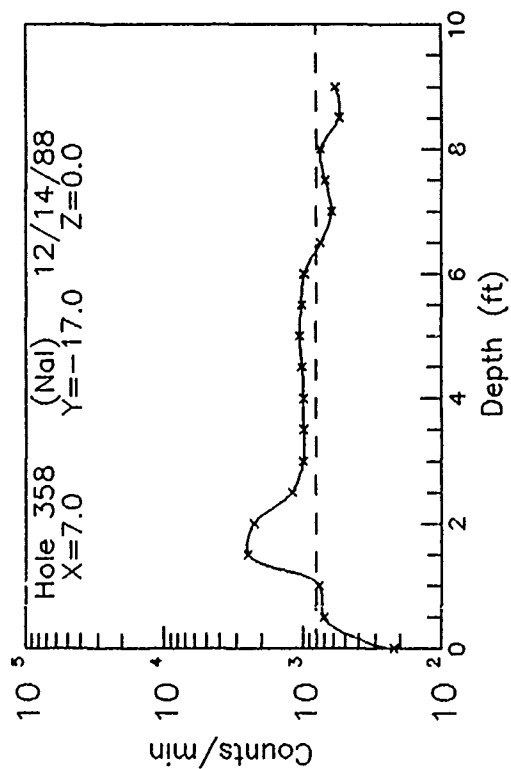
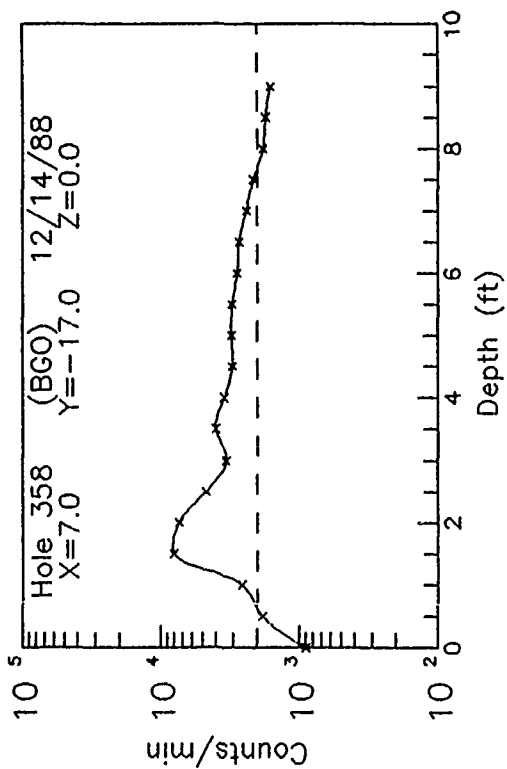
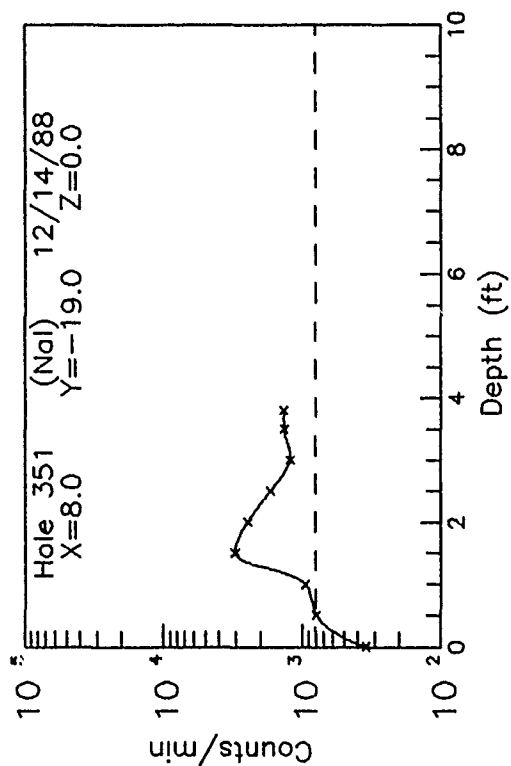
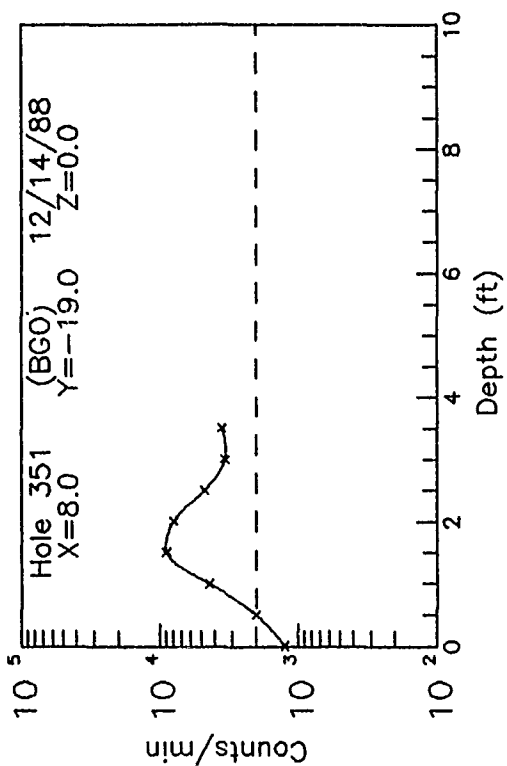


Figure C13. Subsurface Data from 112 Stewart in Map Region 2

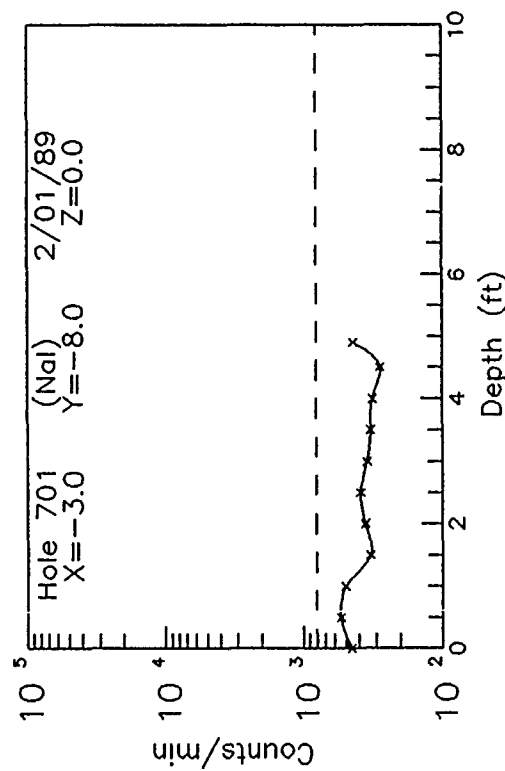
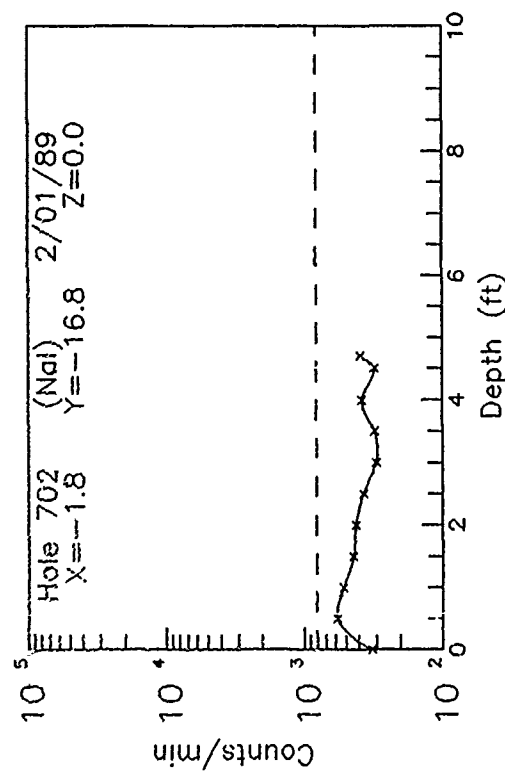
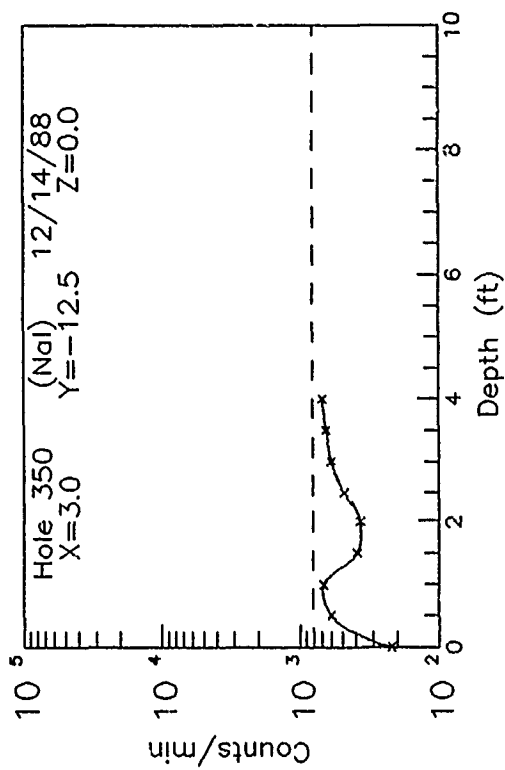
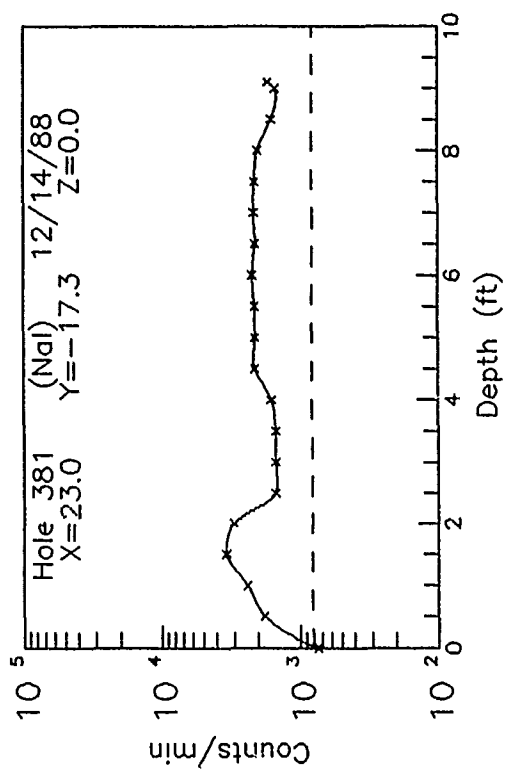


Figure C14. Subsurface Data from 110 and 112 Stewart in Map Region 3

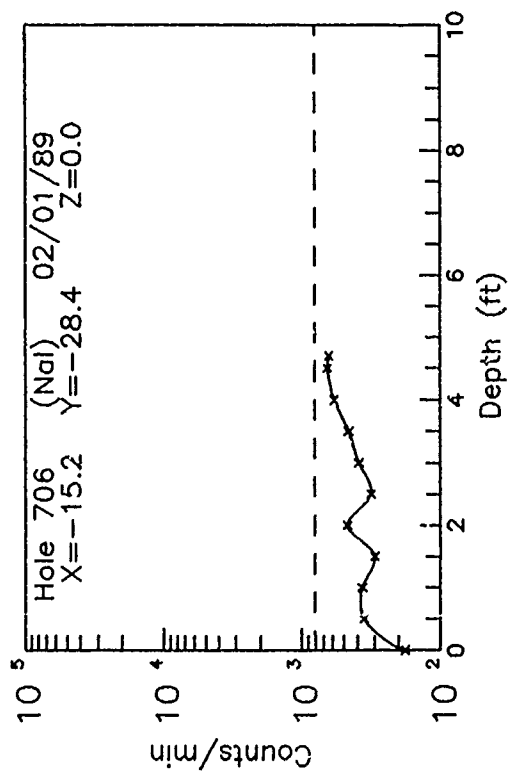
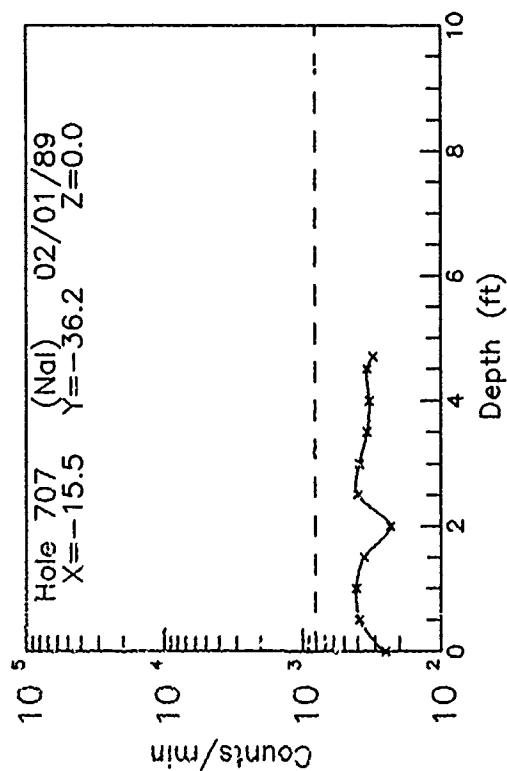
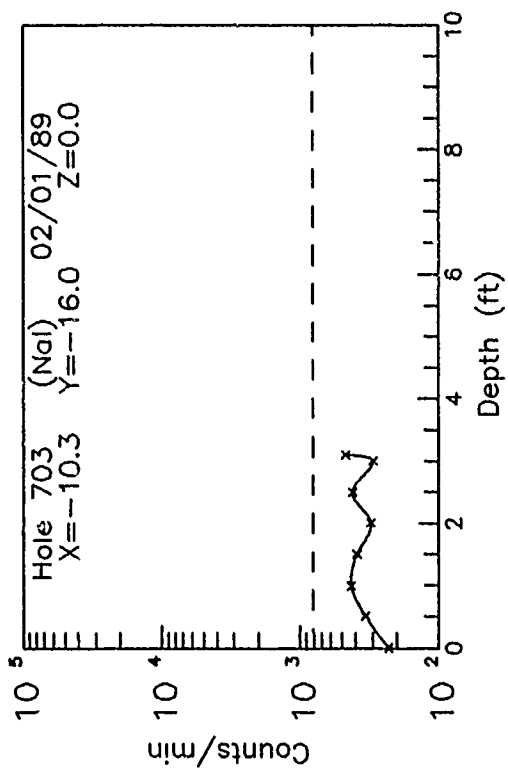
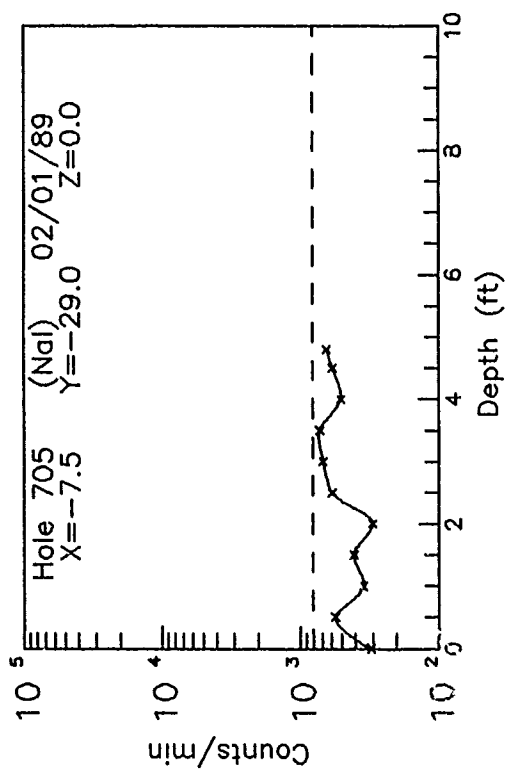


Figure C15. Subsurface Data from 110 Stewart in Map Region 4

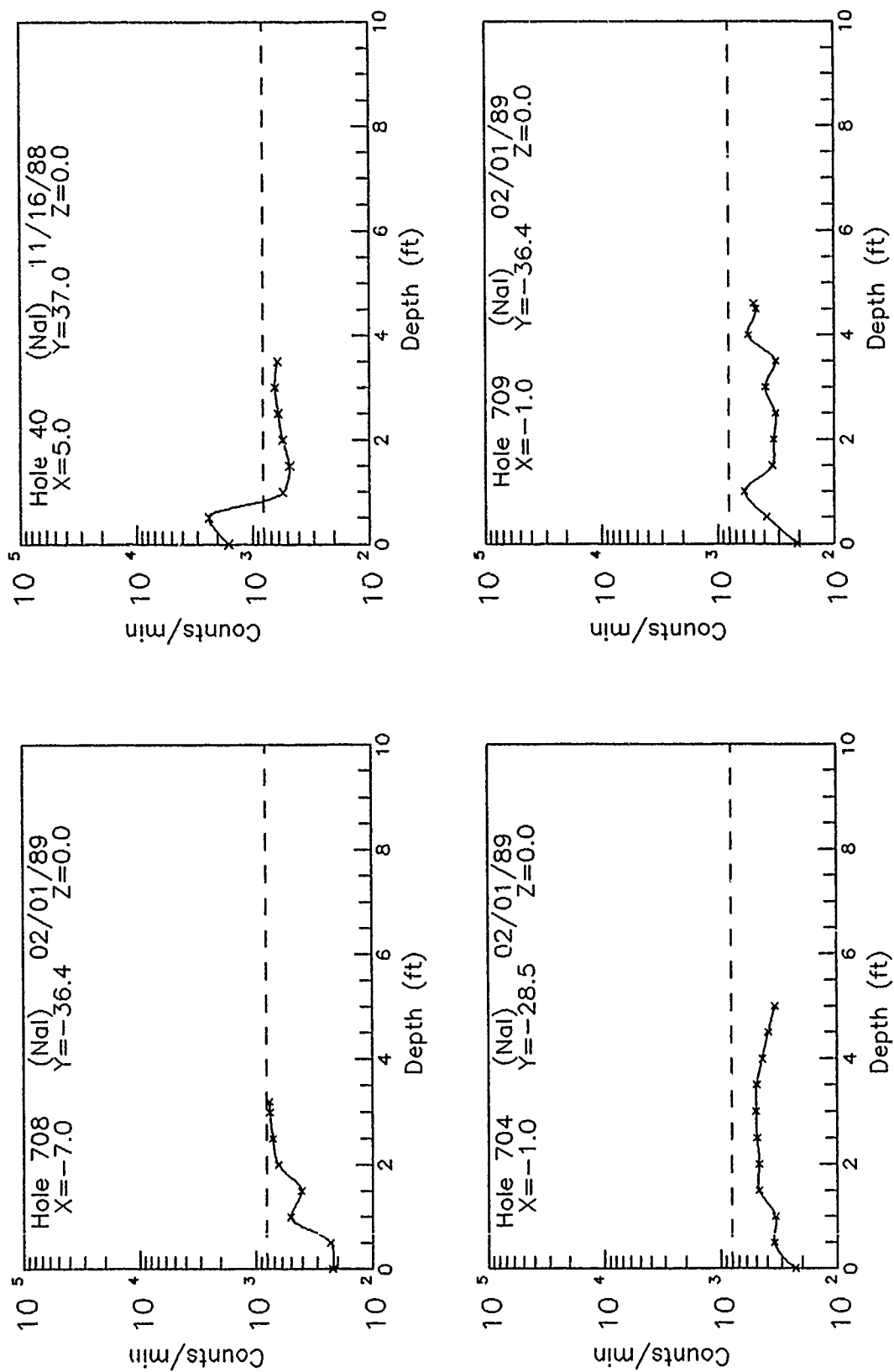


Figure C16. Subsurface Data from 110 and 112 Stewart in Map Region 5

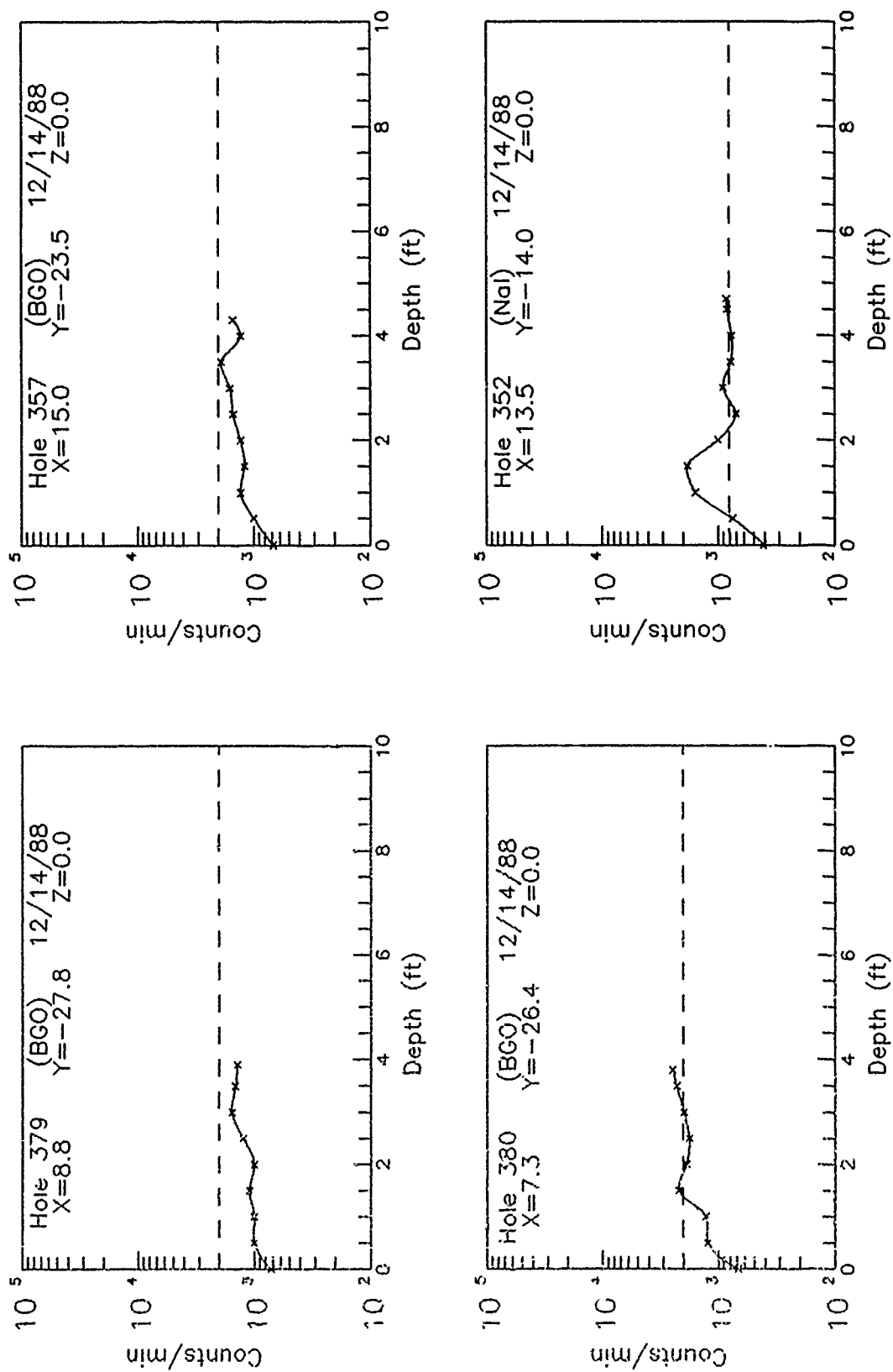


Figure C17. Subsurface Data from 112 Stewart in Map Region 6

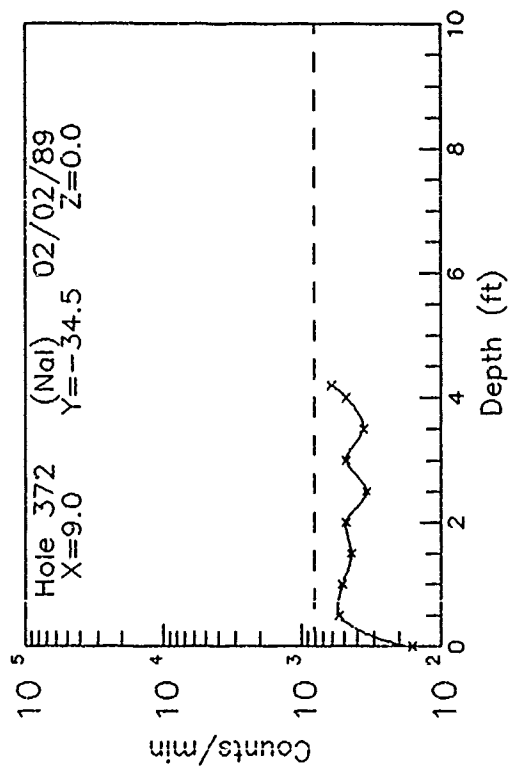
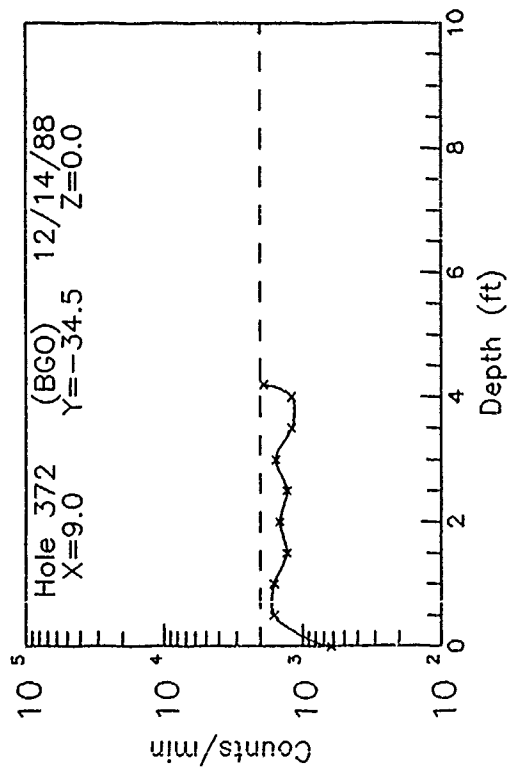
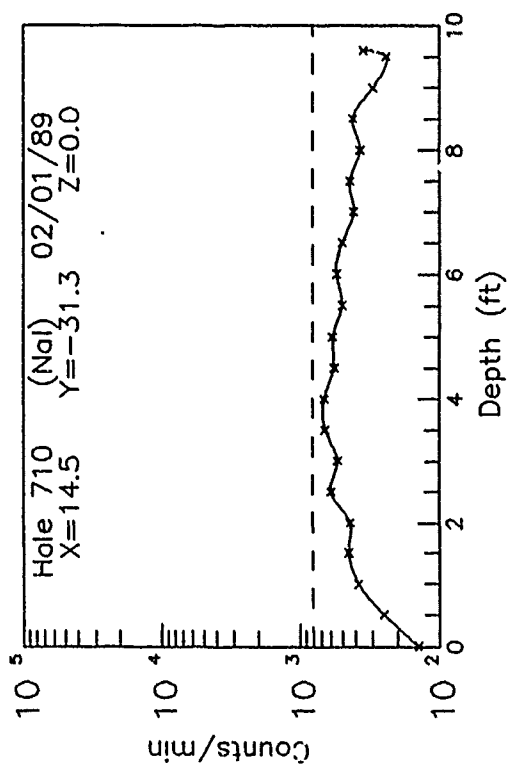
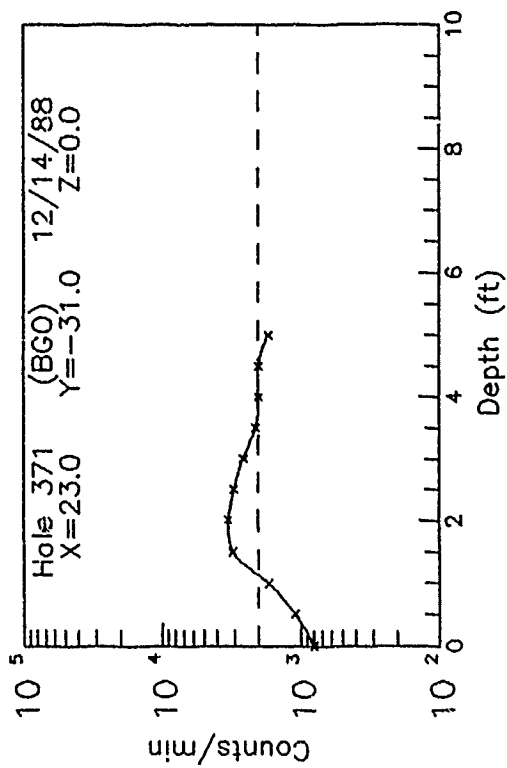


Figure C18. Subsurface Data from 112 Stewart in Map Region 7

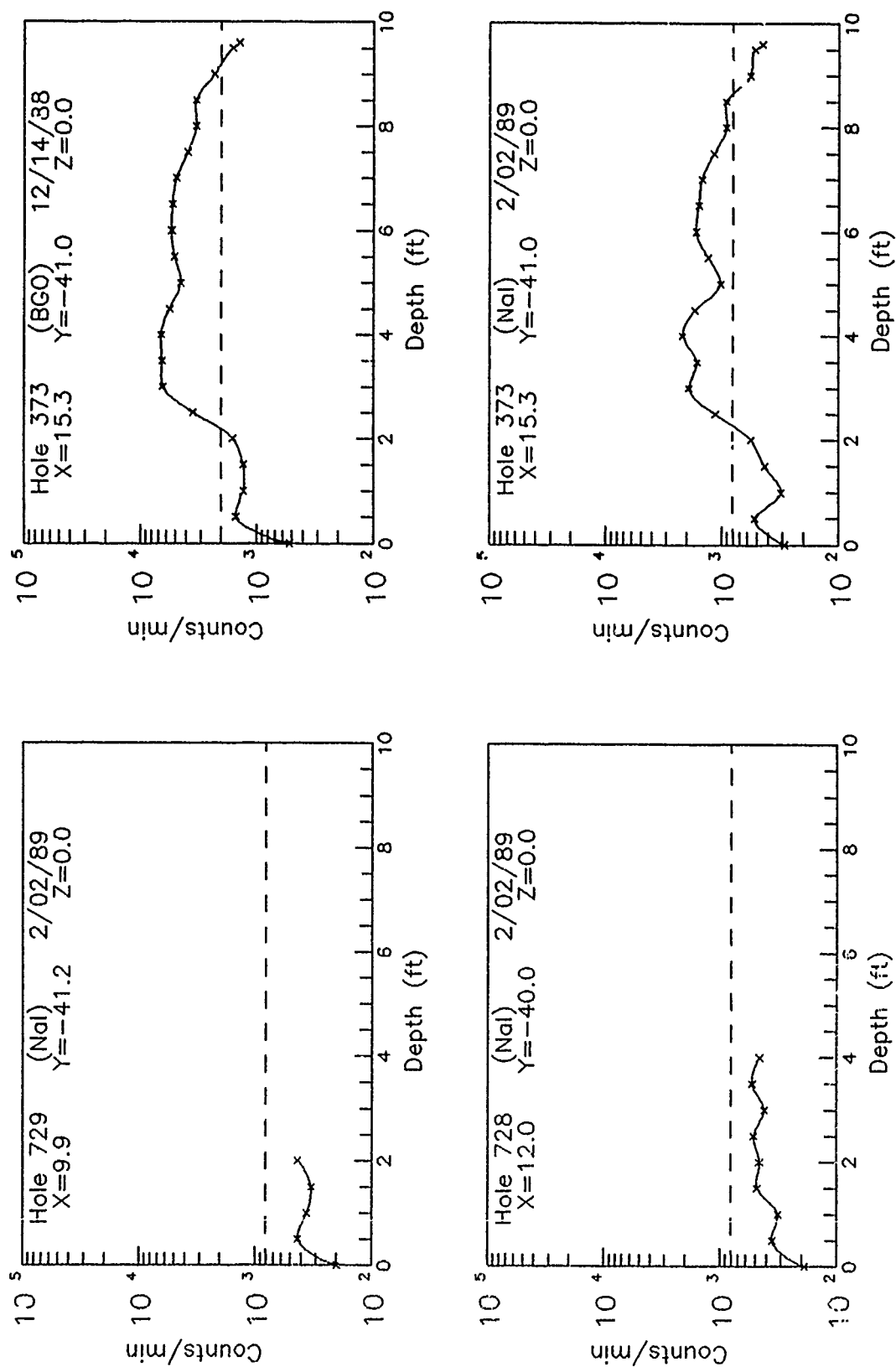


Figure C19. Subsurface Data from 112 Stewart in Map Region 8

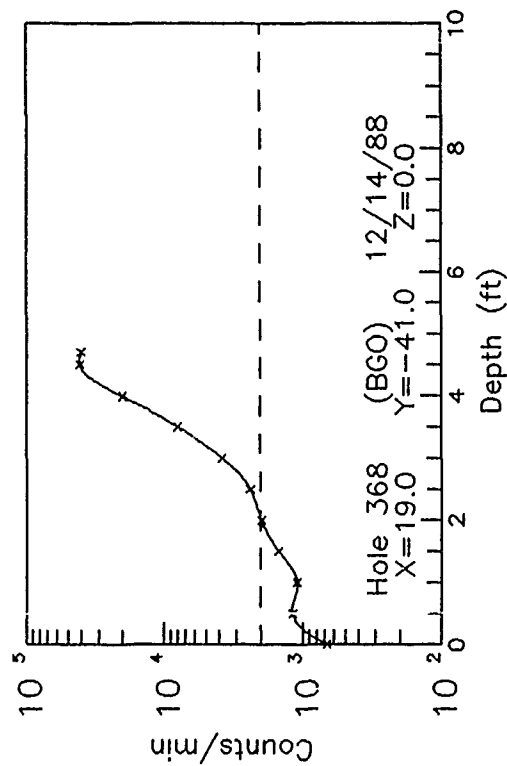
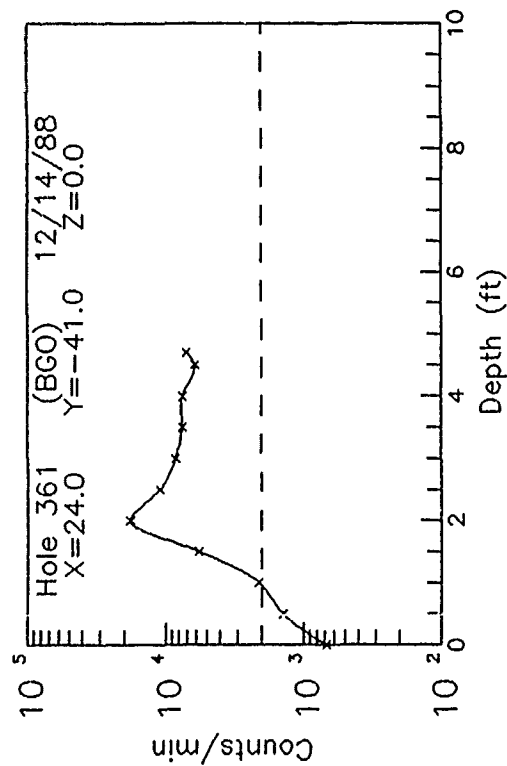
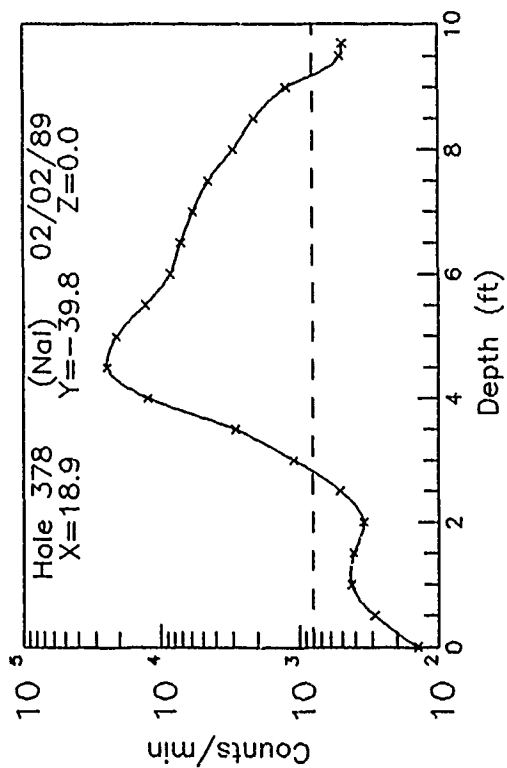
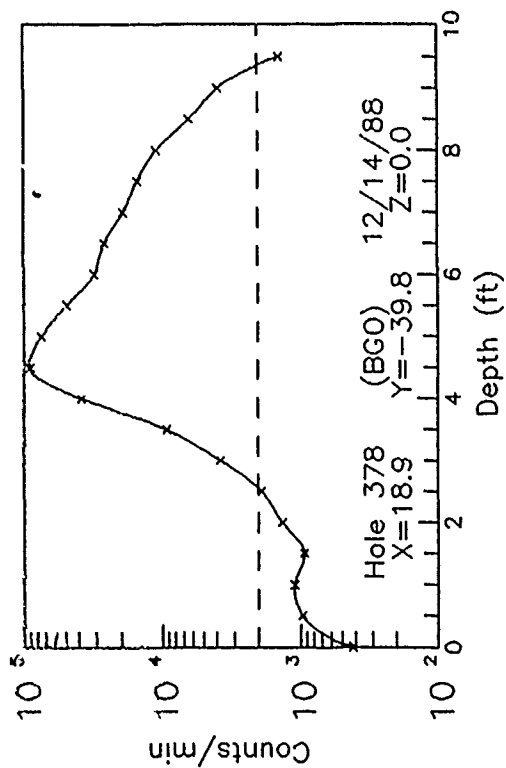


Figure C20. Subsurface Data from 112 Stewart in Map Region 9

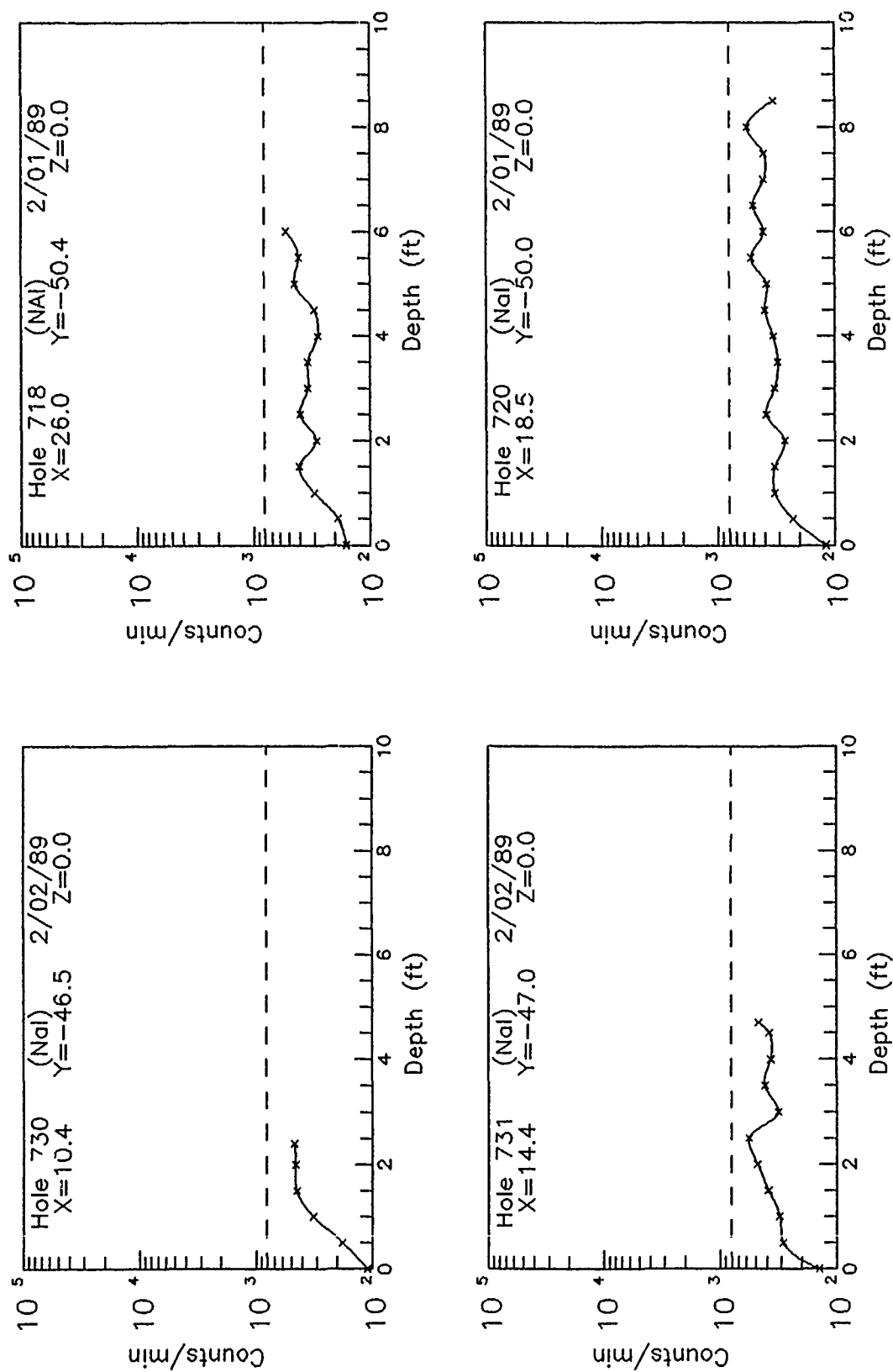


Figure C21. Subsurface Data from 112 Stewart in Map Region 10

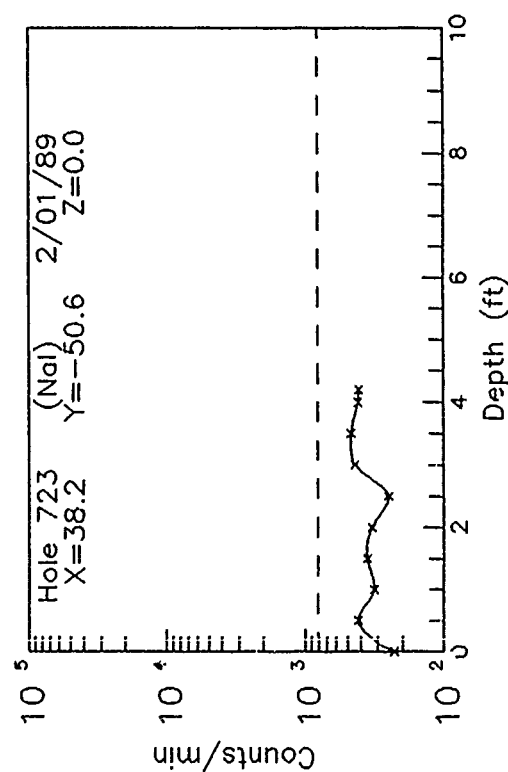
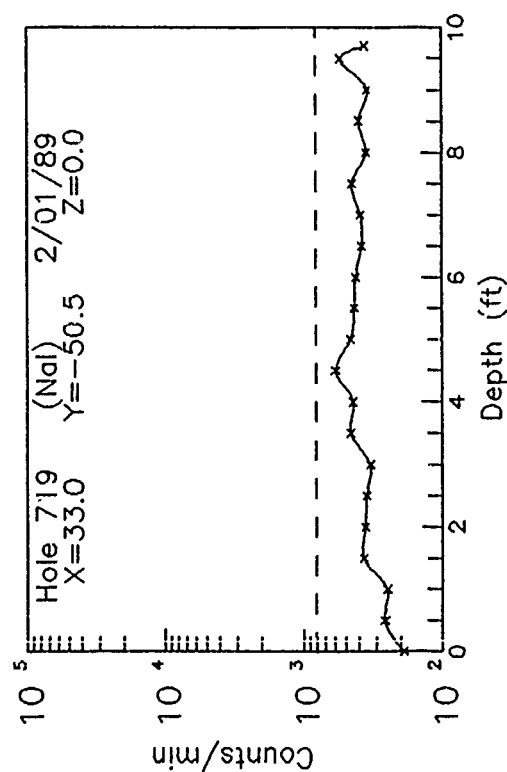
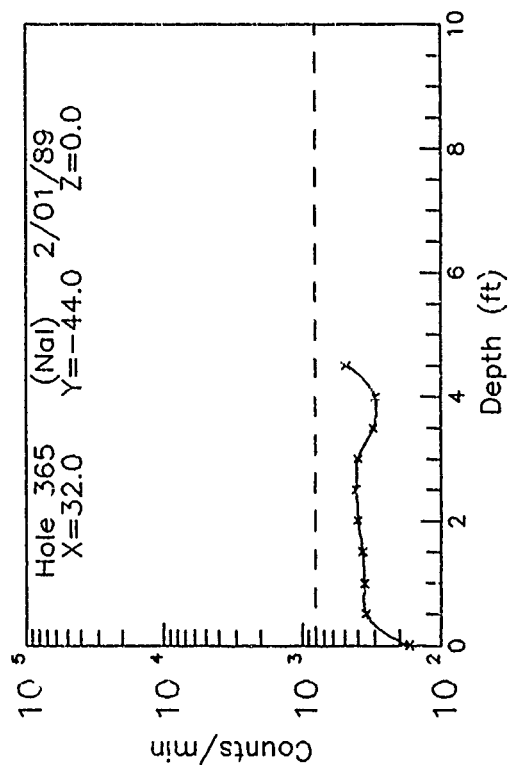
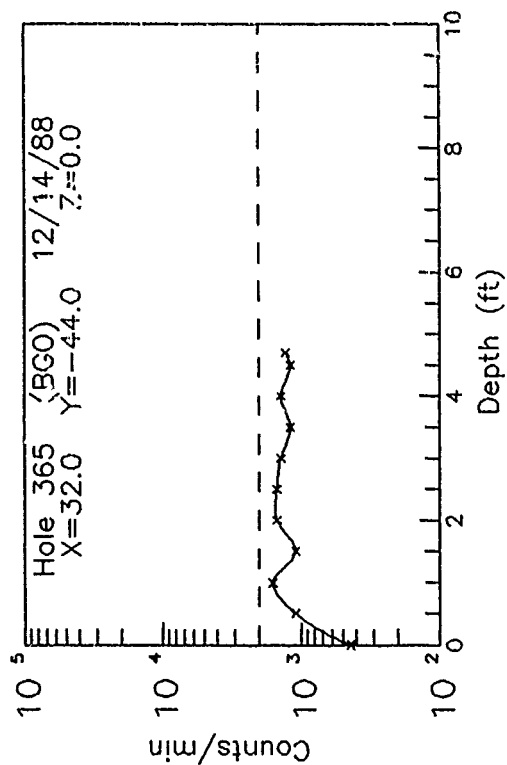


Figure C22. Subsurface Data from 112 Stewart in Map Region 11

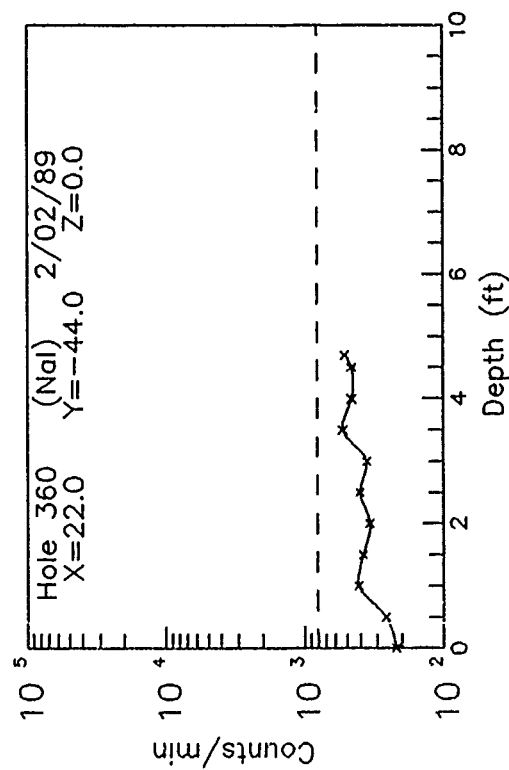
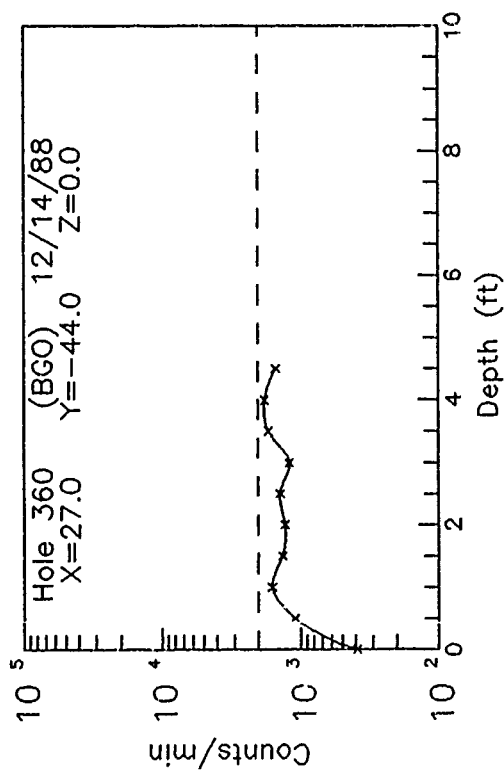
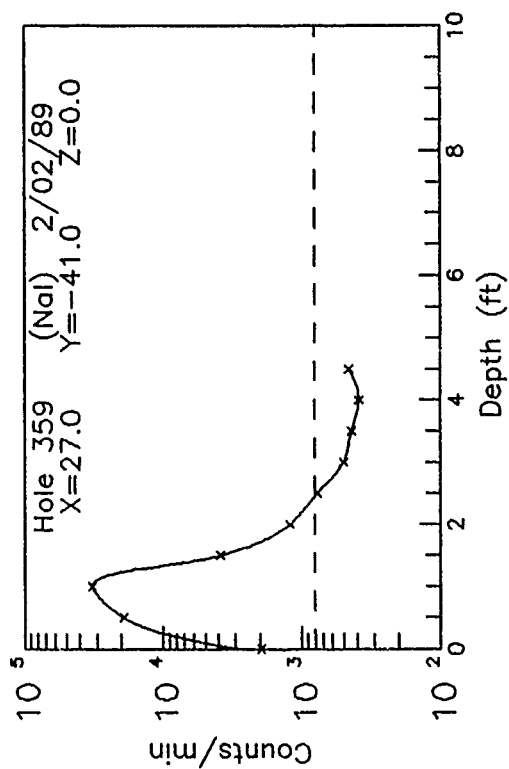
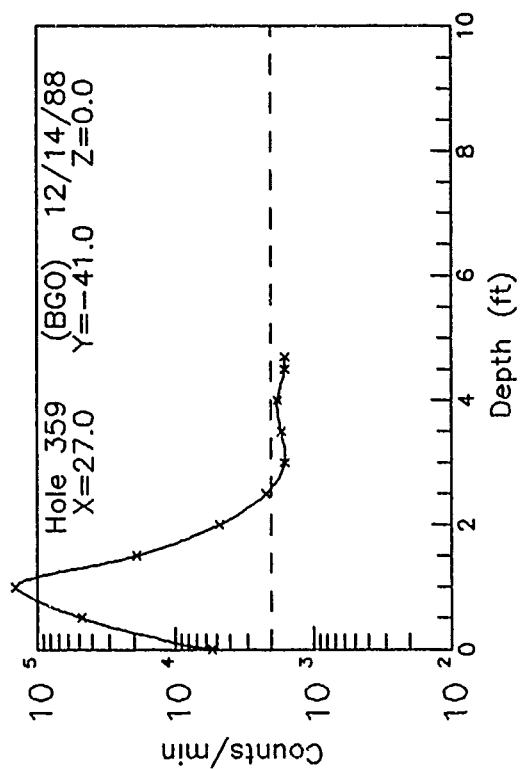


Figure C23. Subsurface Data from 112 Stewart in Map Region 12

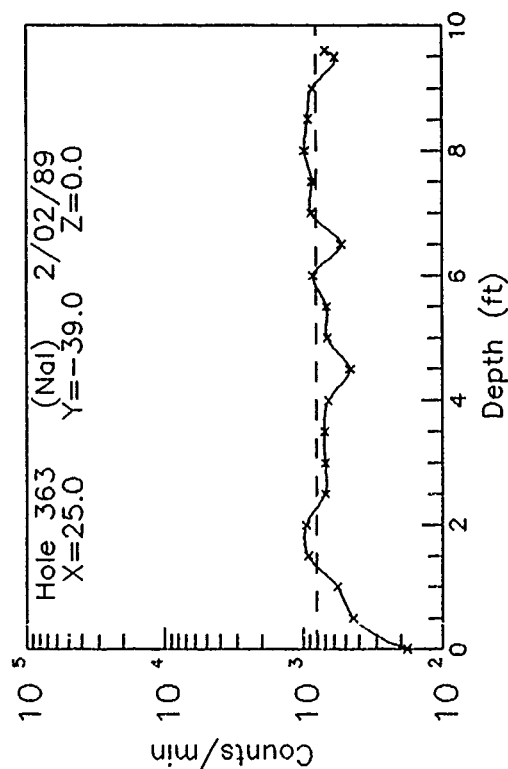
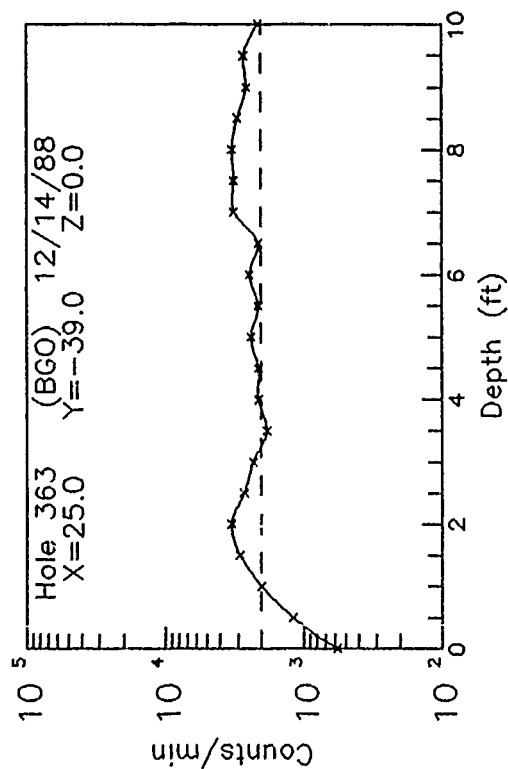
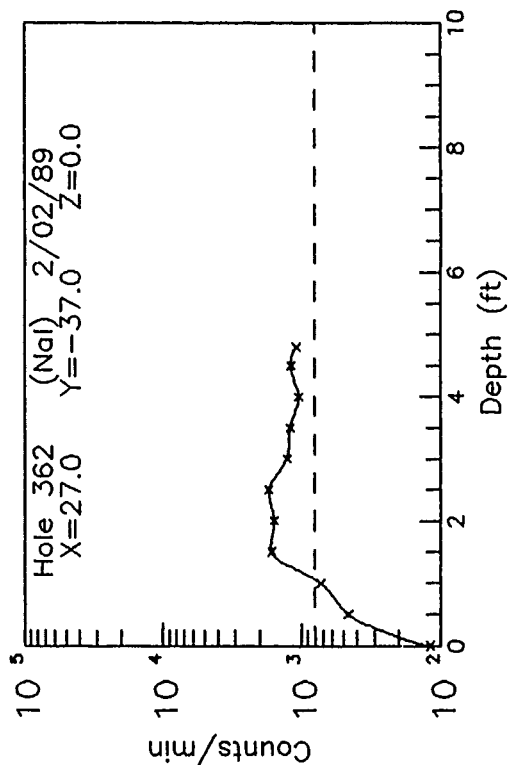
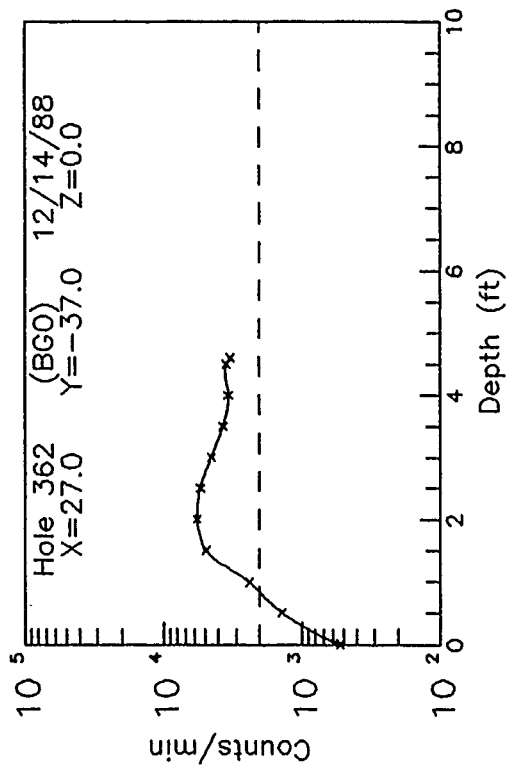


Figure C24. Subsurface Data from 112 Stewart in Map Region 13

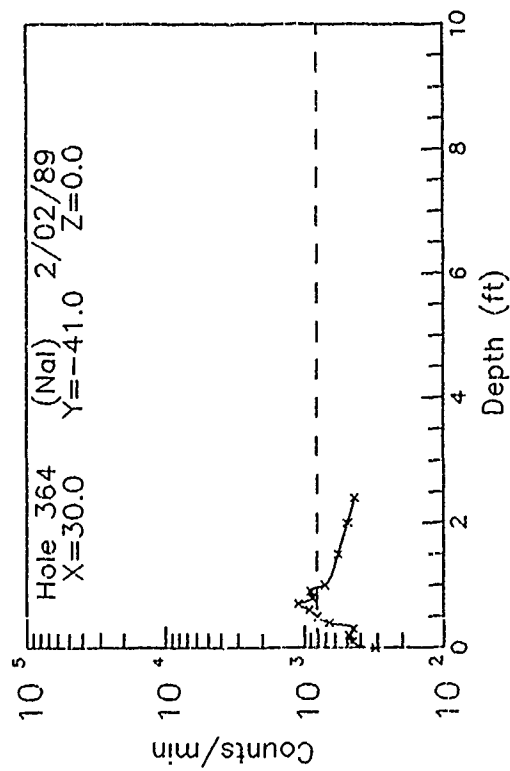
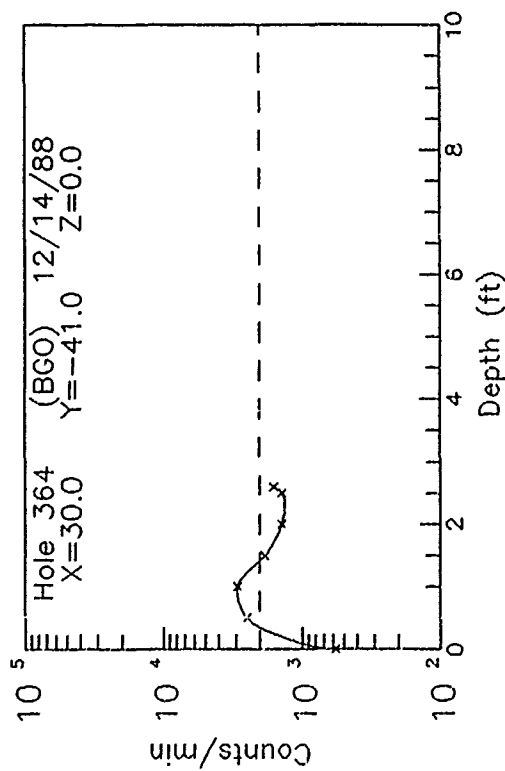
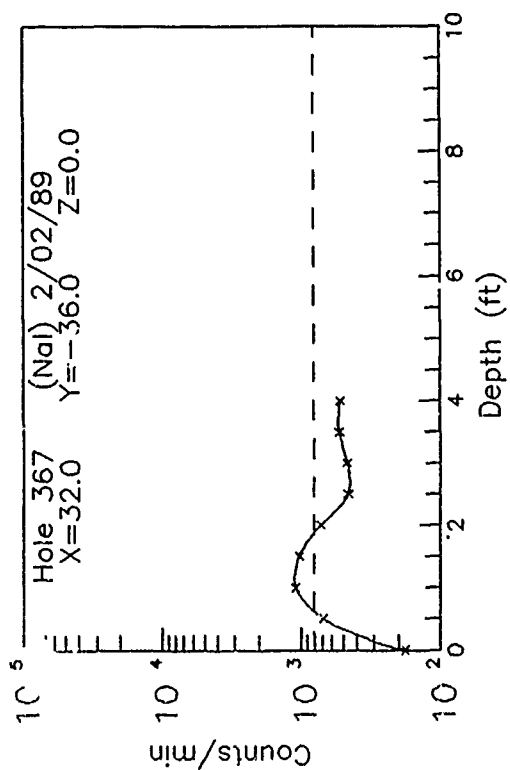
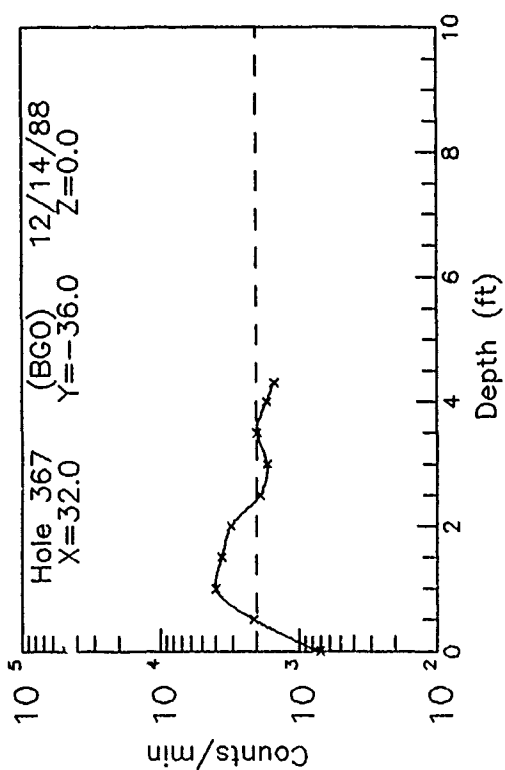


Figure C25. Subsurface Data from 112 Stewart in Map Region 14.

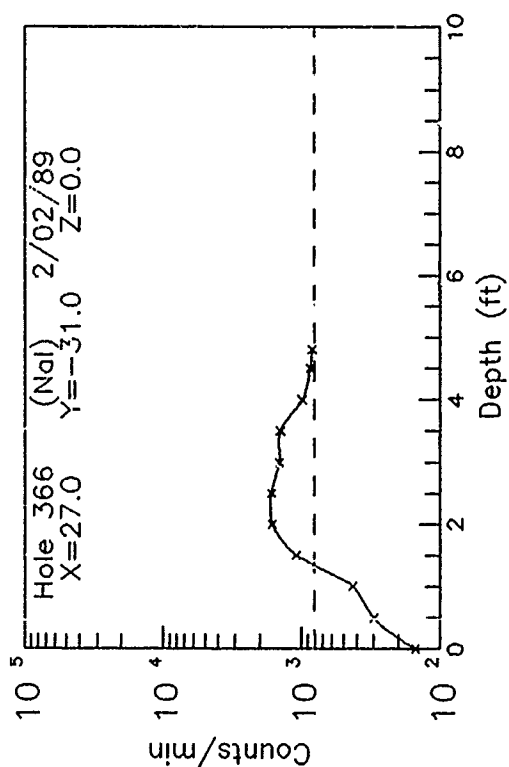
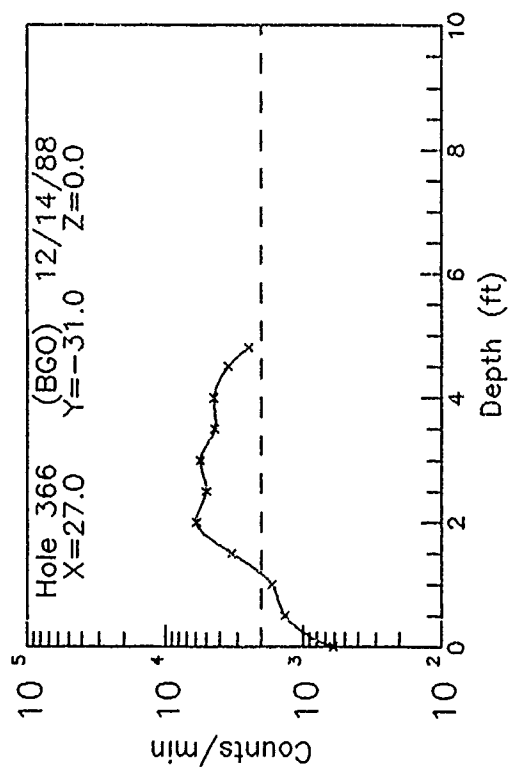
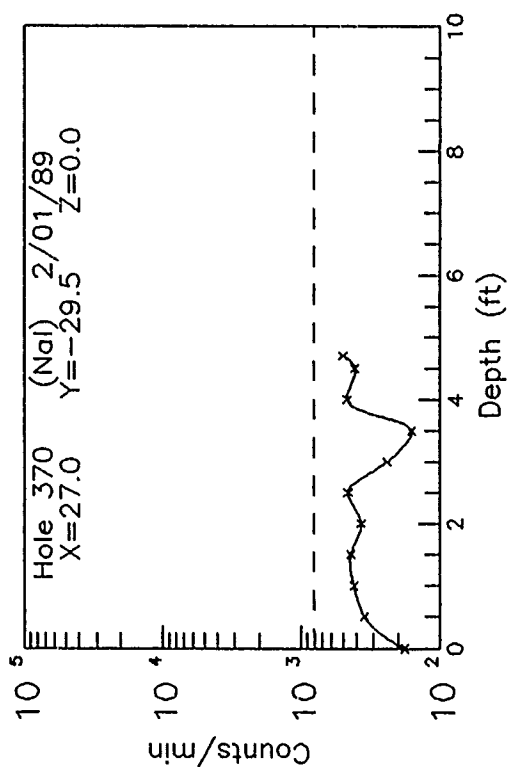
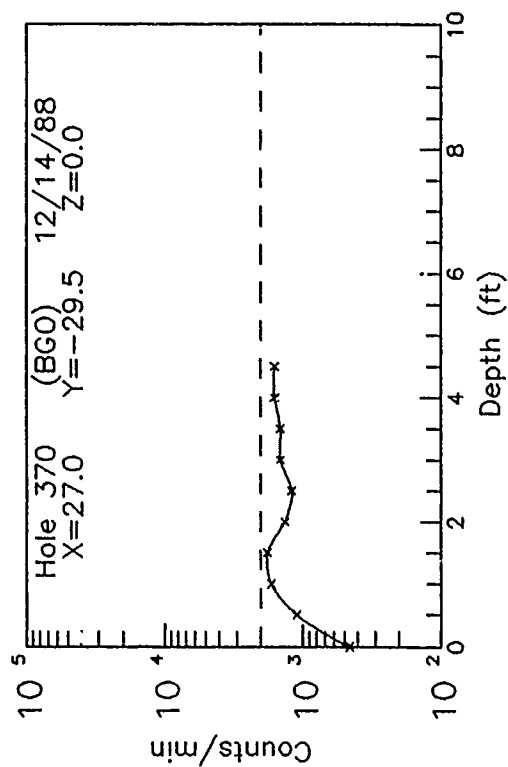


Figure C26. Subsurface Data from 112 Stewart in Map Region 15

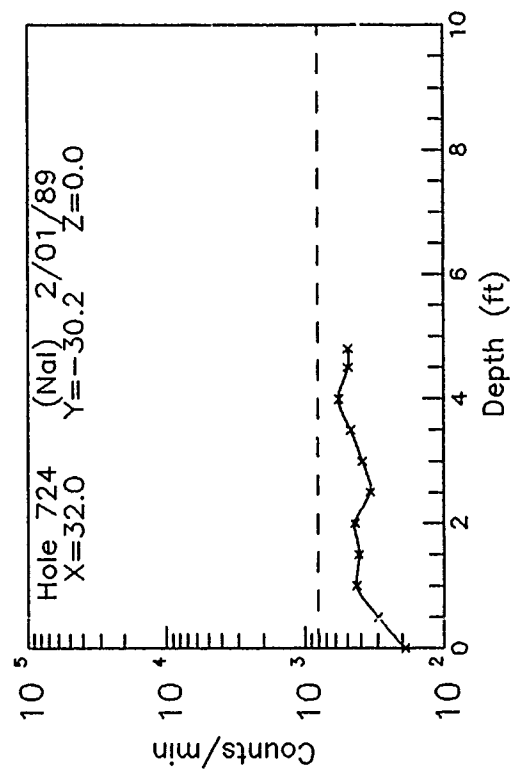
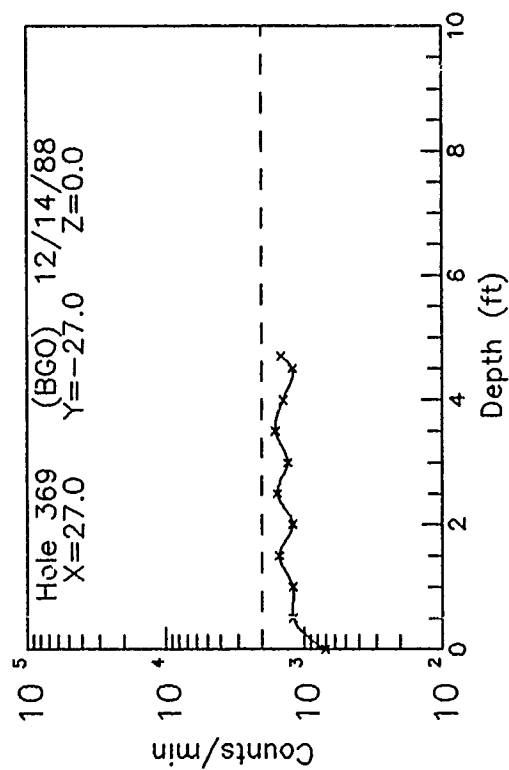
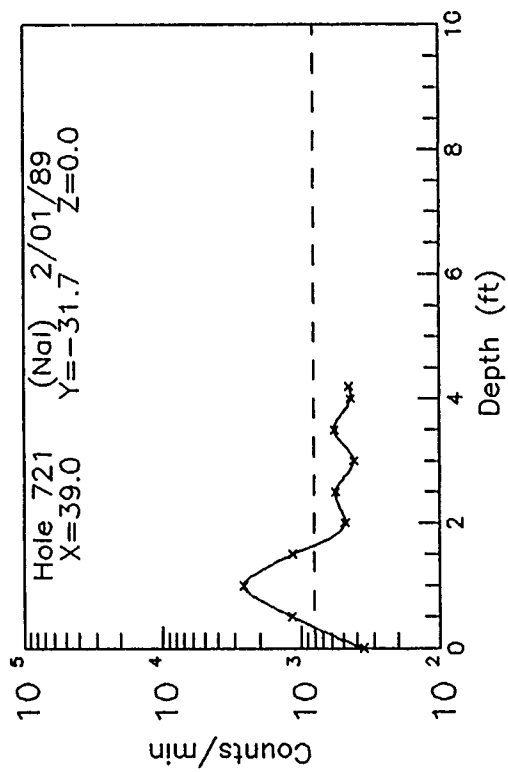
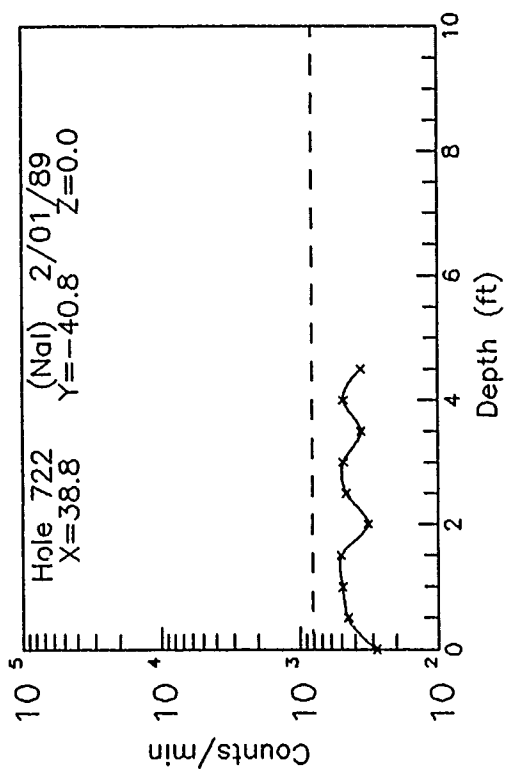


Figure C27. Subsurface Data from 112 Stewart in Map Region 16

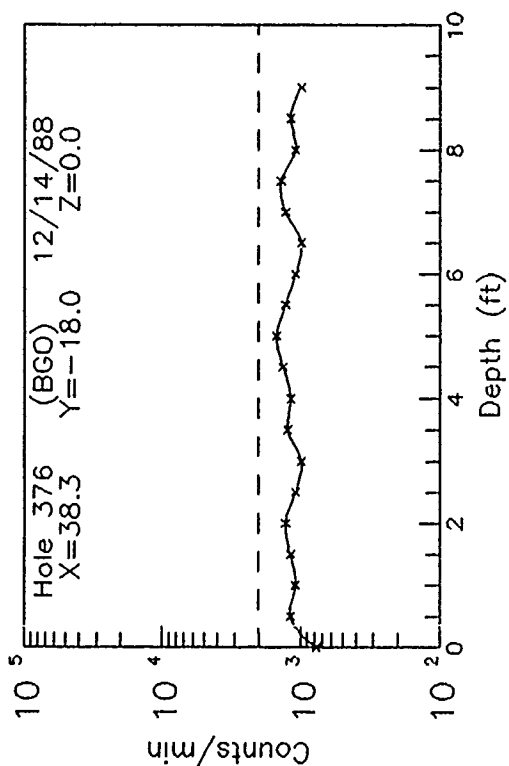
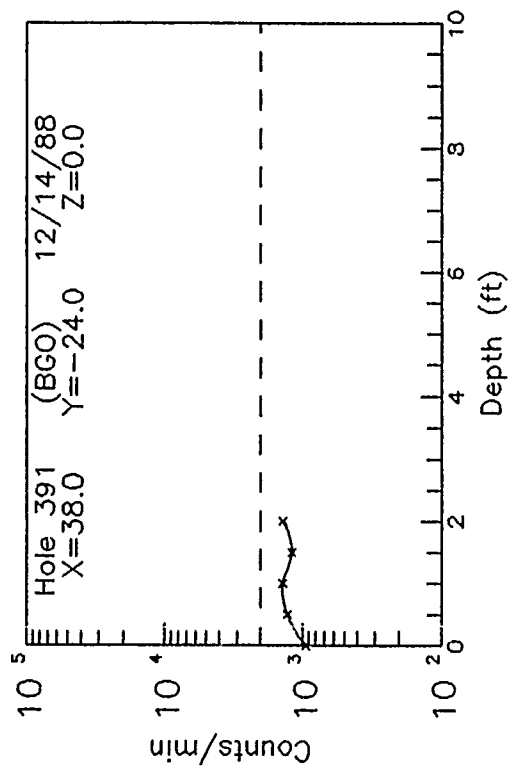
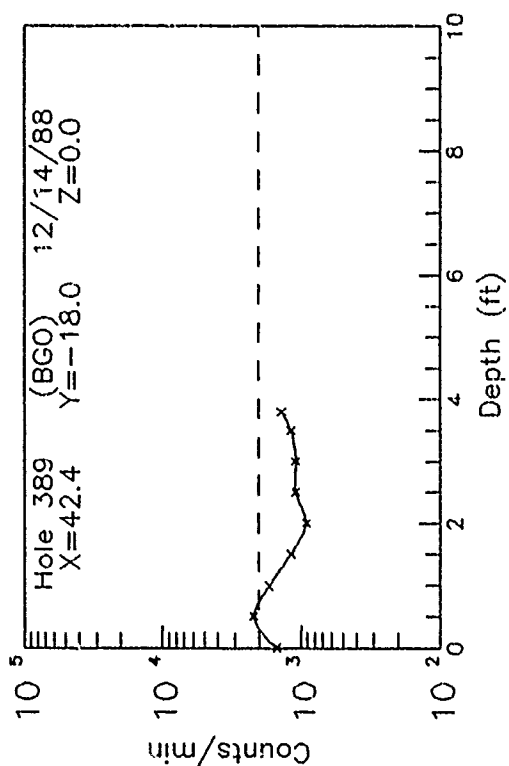
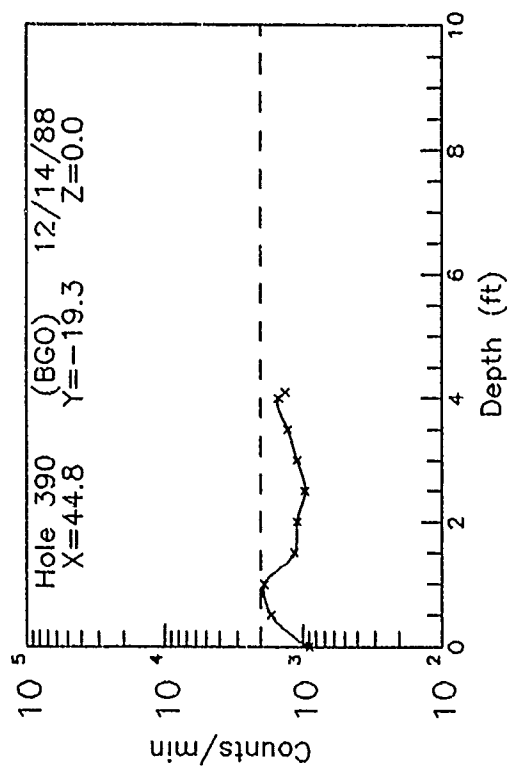


Figure C28. Subsurface Data from 112 Stewart in Map Region 17

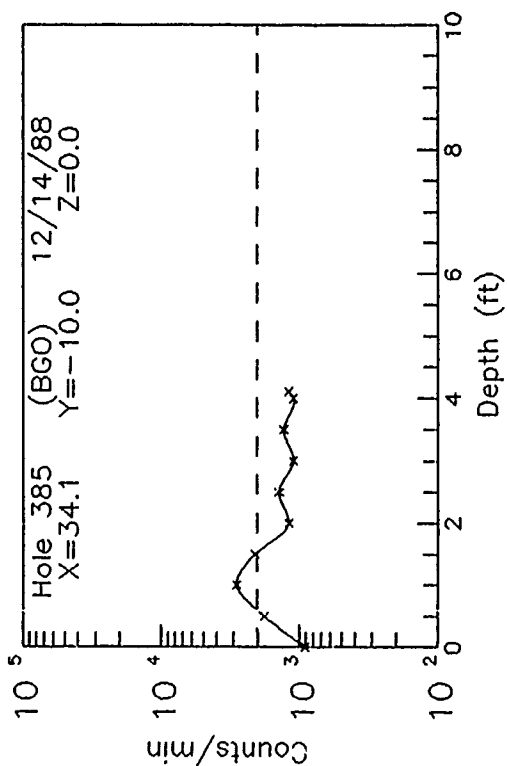
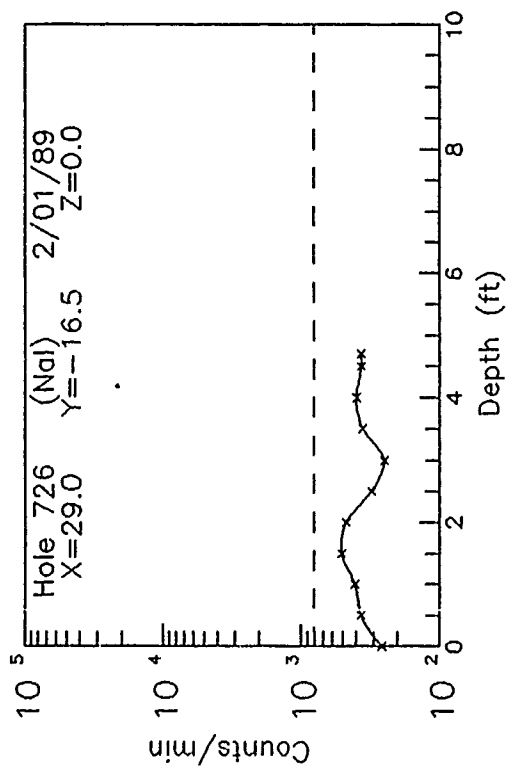
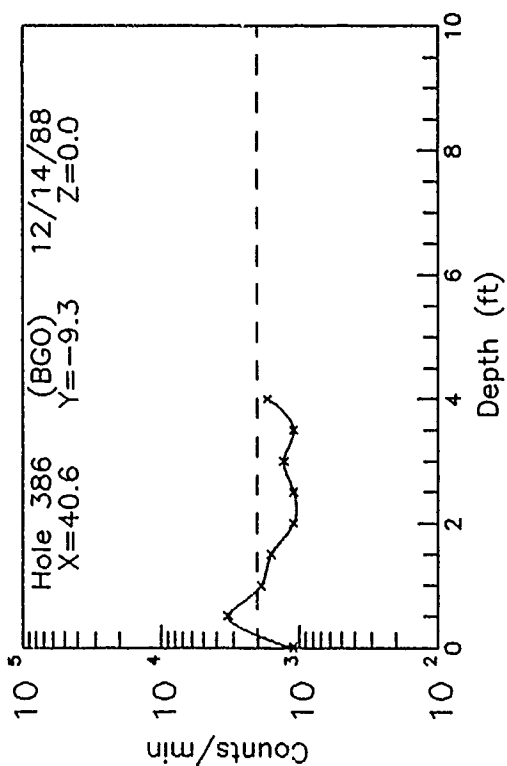
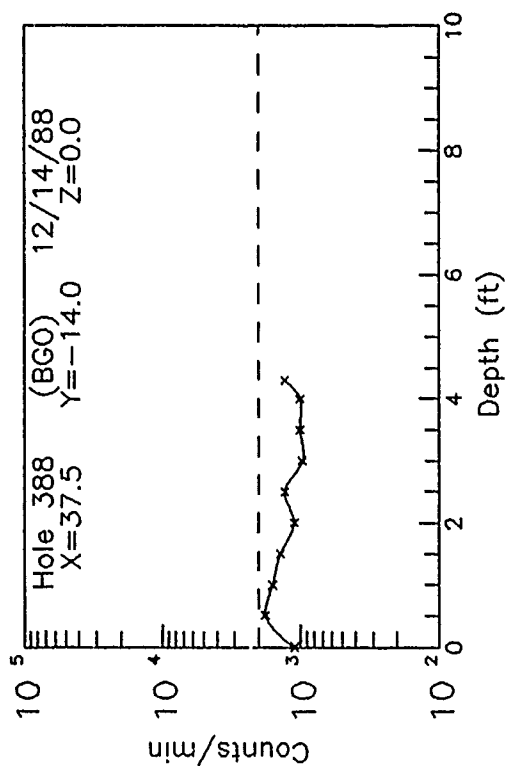


Figure C29. Subsurface Data from 112 Stewart in Map Region 18

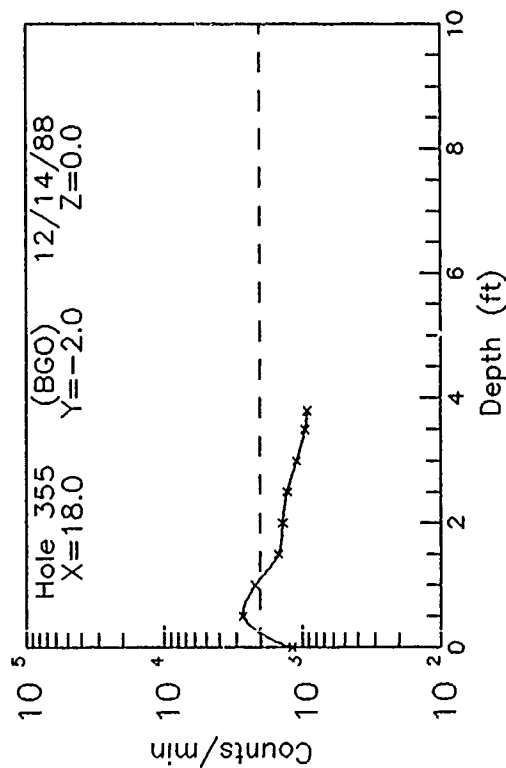
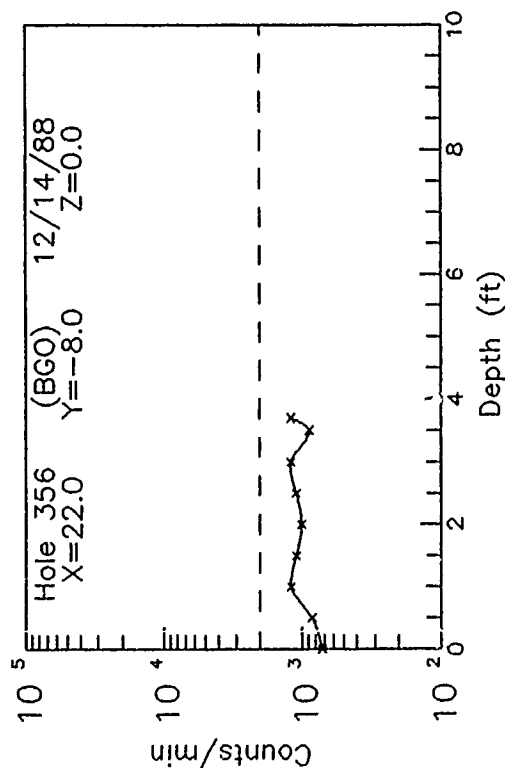
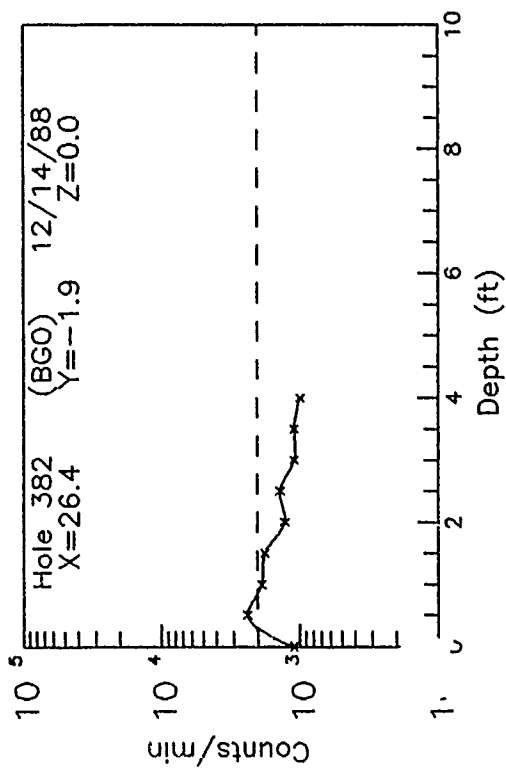
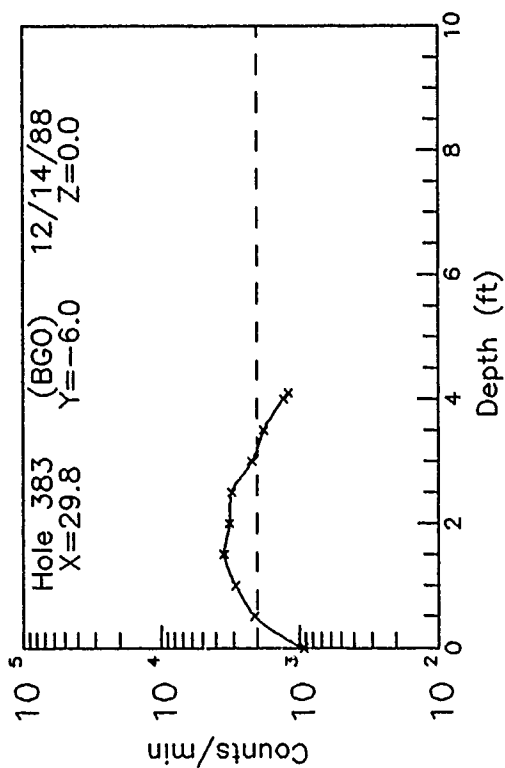


Figure C30. Subsurface Data from 112 Stewart in Map Region 19

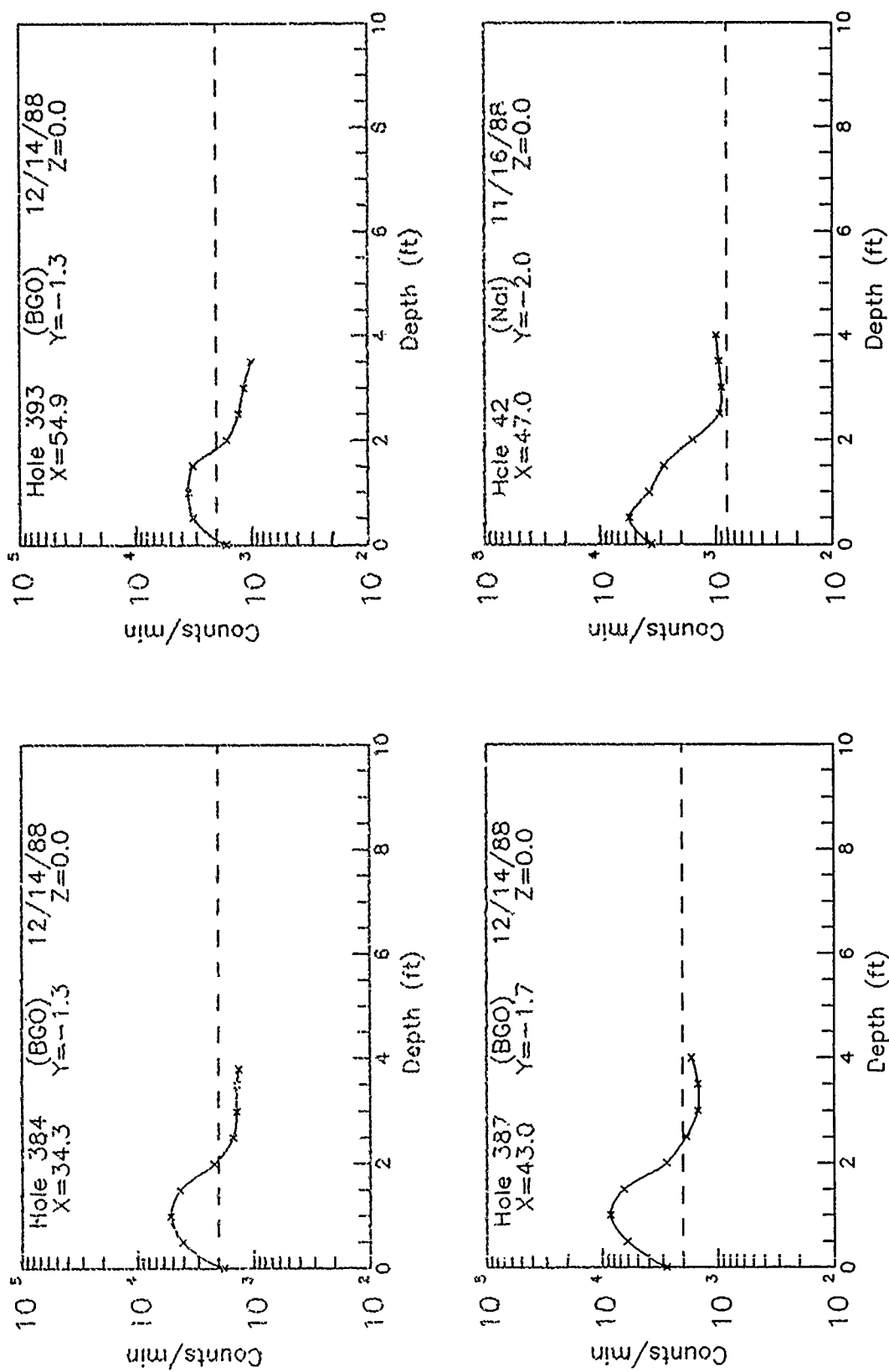


Figure C31. Subsurface Data from 112 Stewart in Map Region 20

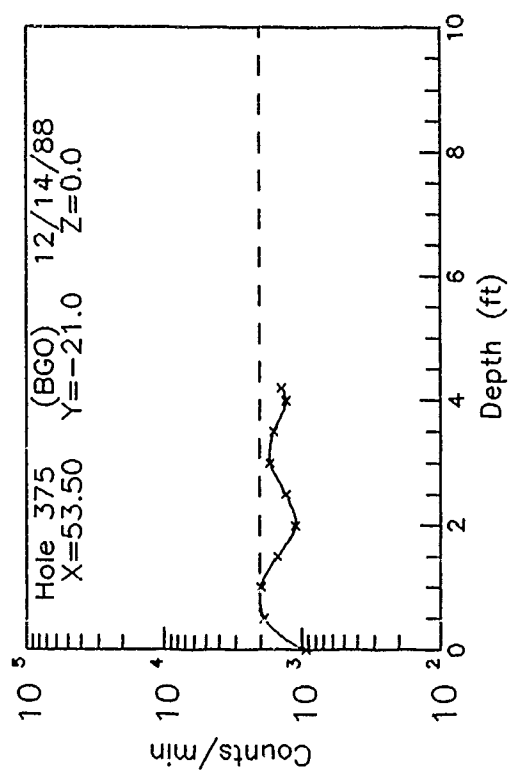
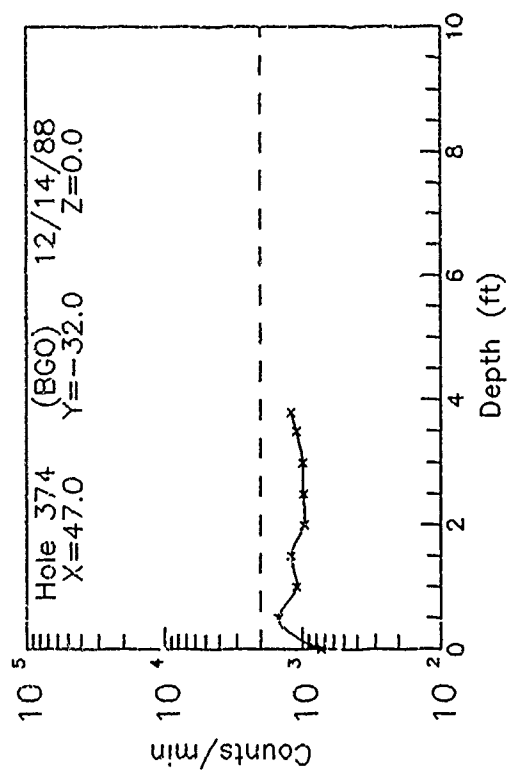
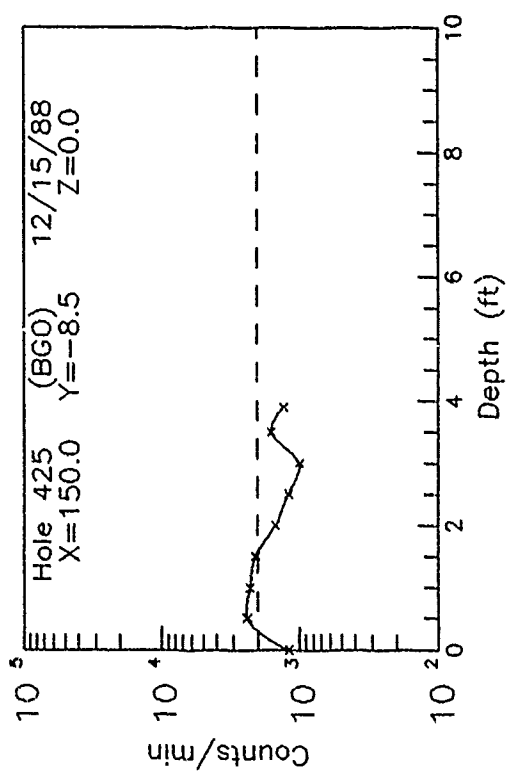
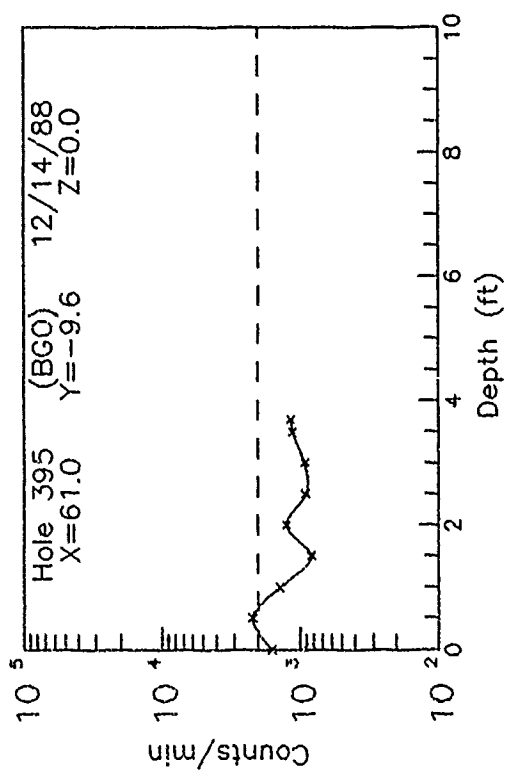


Figure C32. Subsurface Data from 112 Stewart in Map Region 21

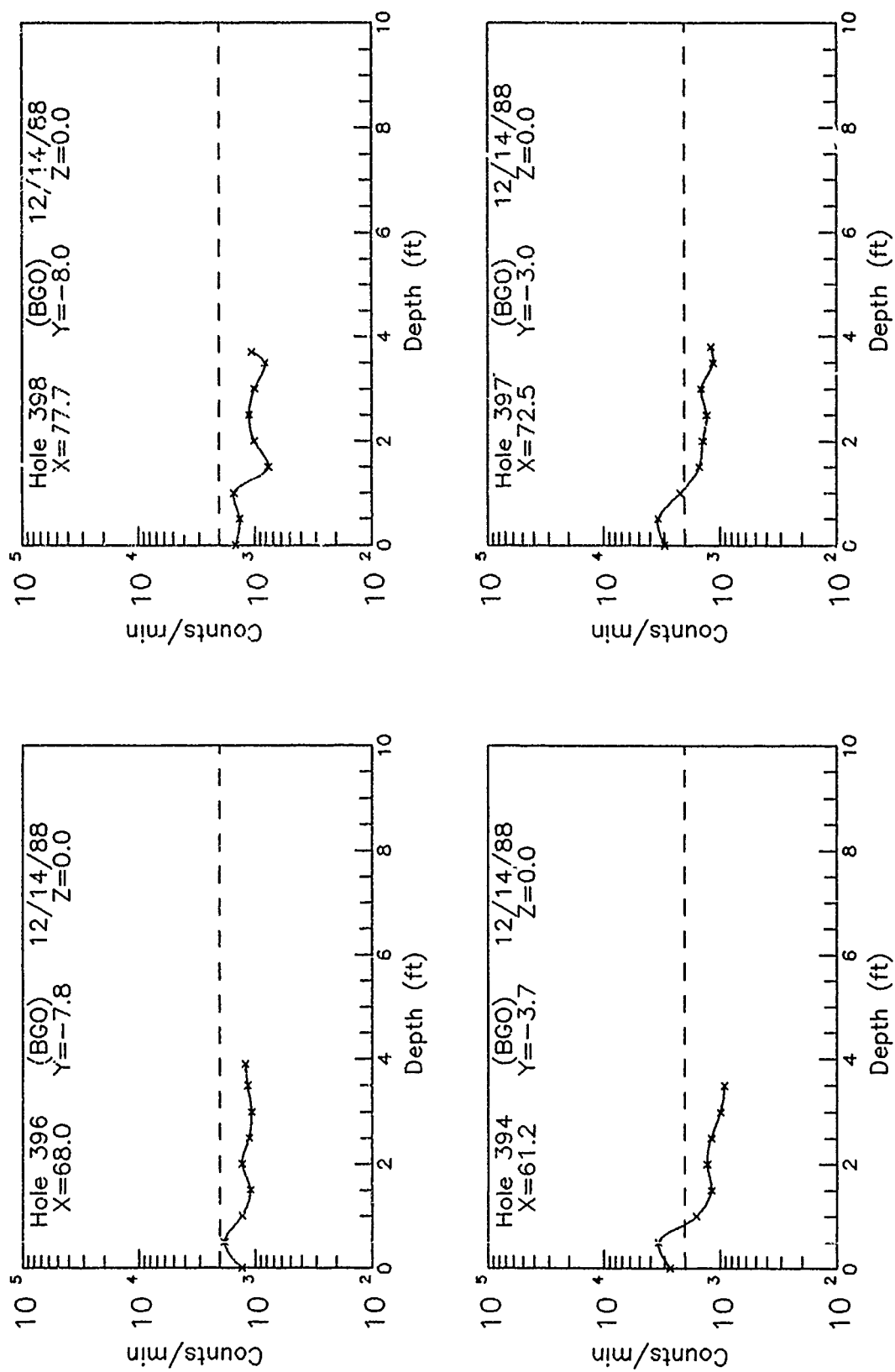


Figure C33. Subsurface Data from 114 Stewart in Map Region 22

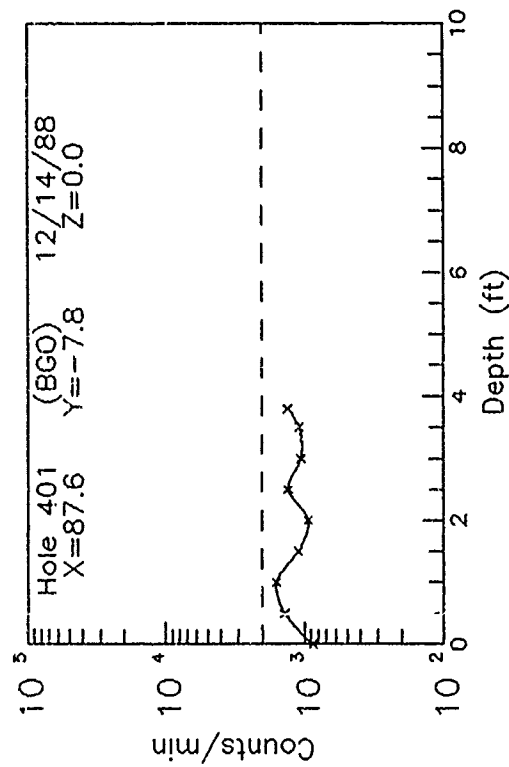
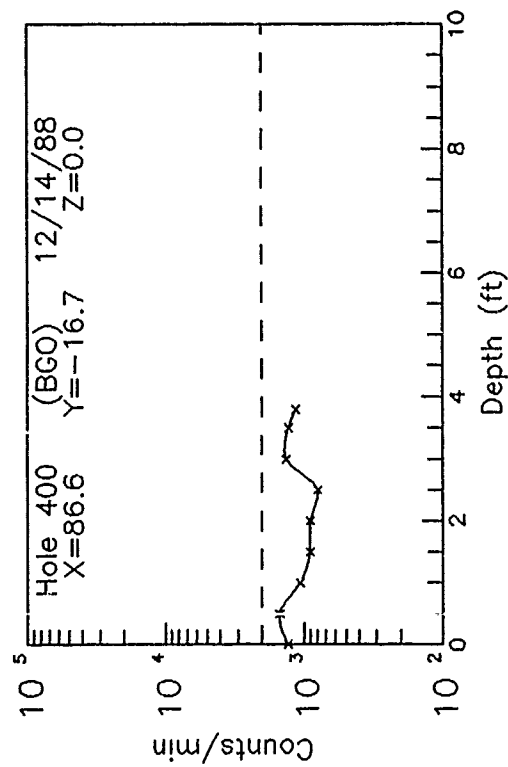
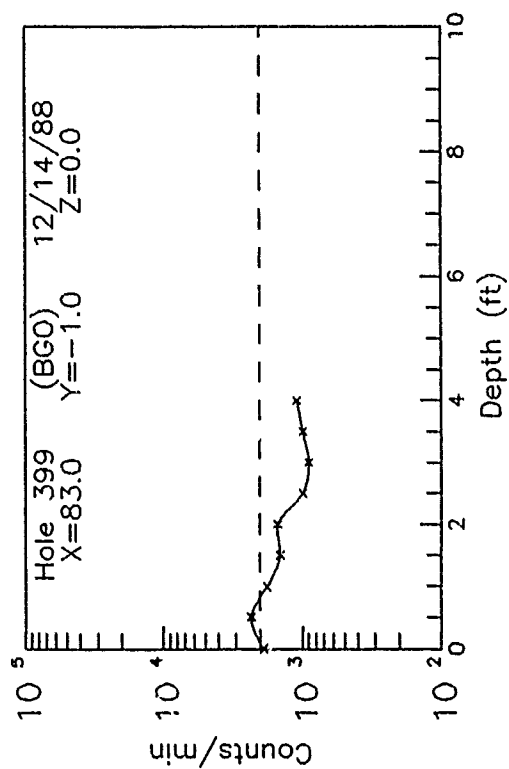
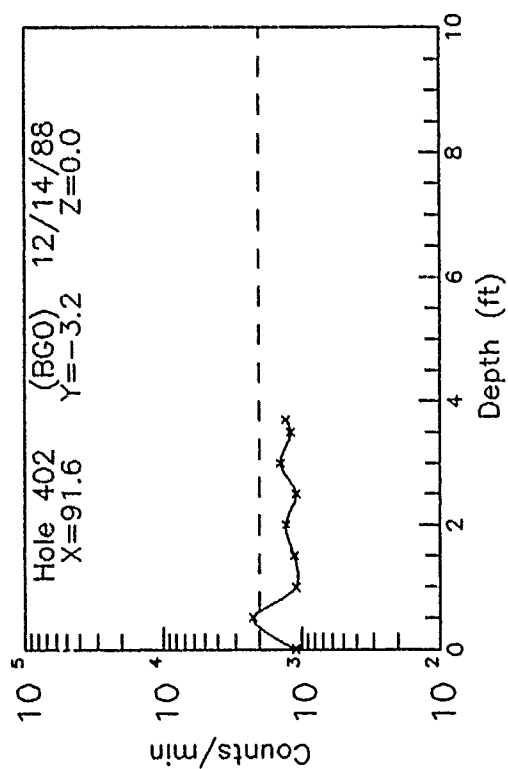


Figure C34. Subsurface Data from 114 Stewart in Map Region 23

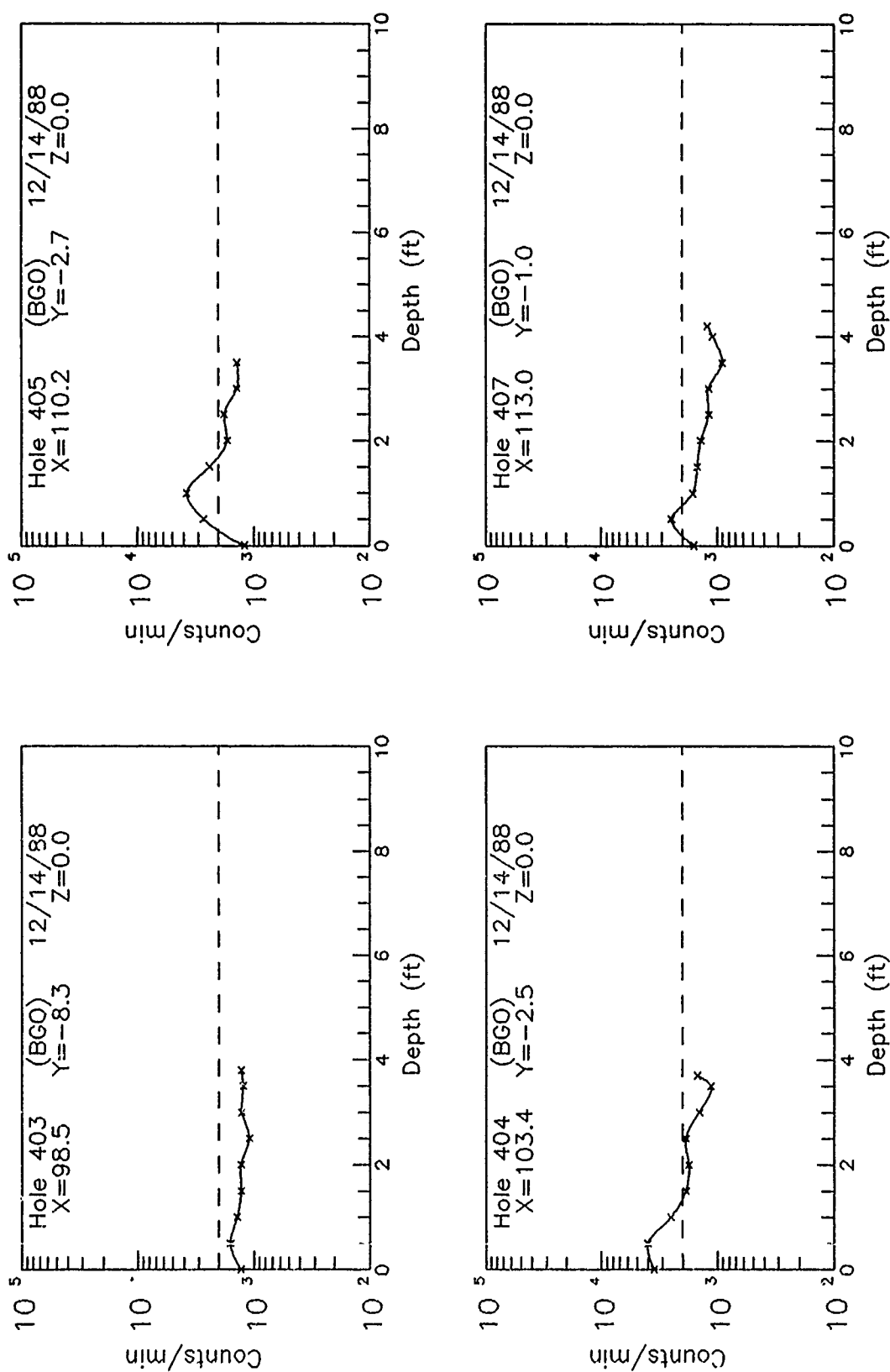


Figure C35. Subsurface Data from 114 Stewart in Map Region 24

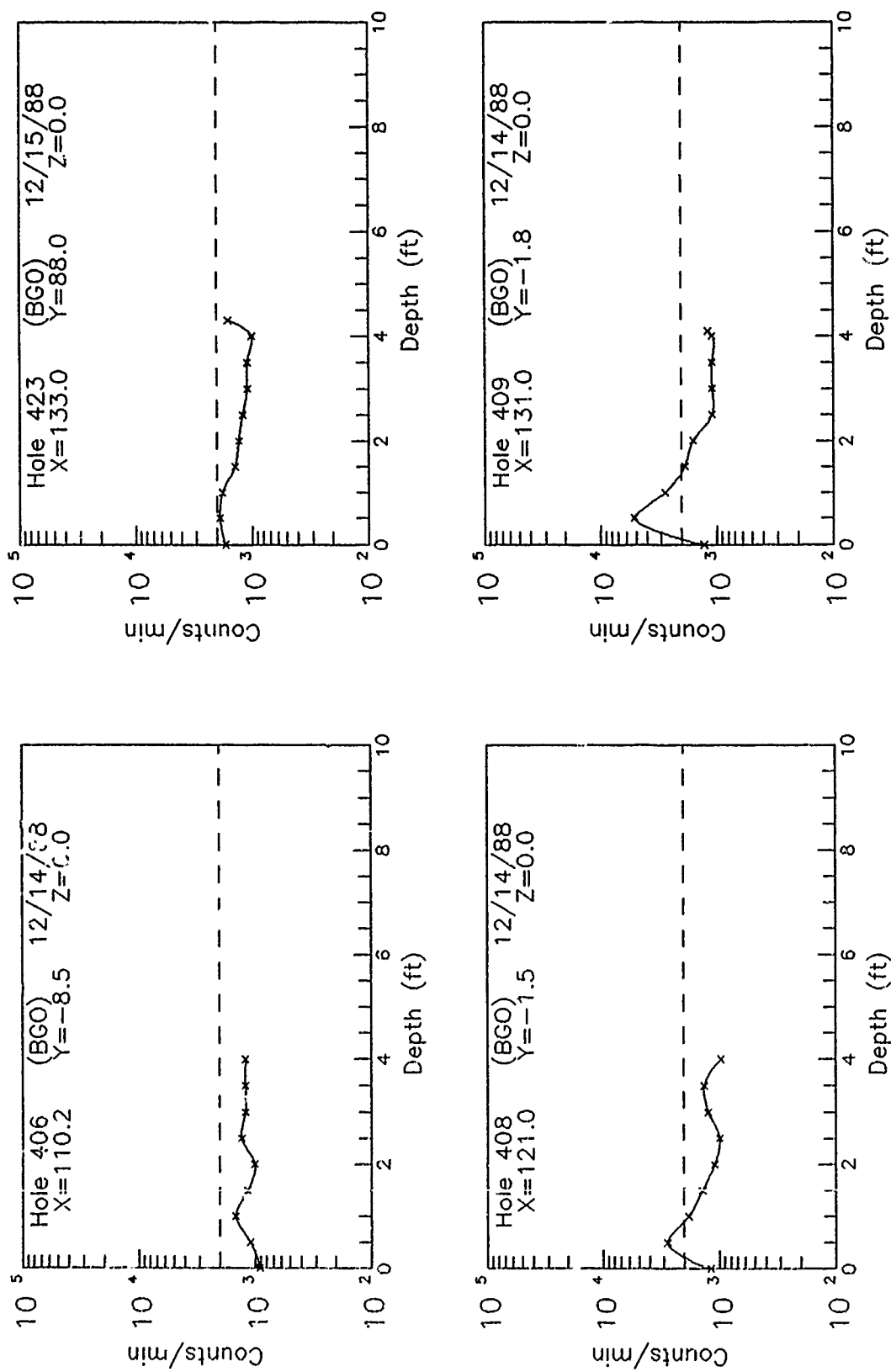


Figure C36. Subsurface Data from 60 Union in Map Region 25

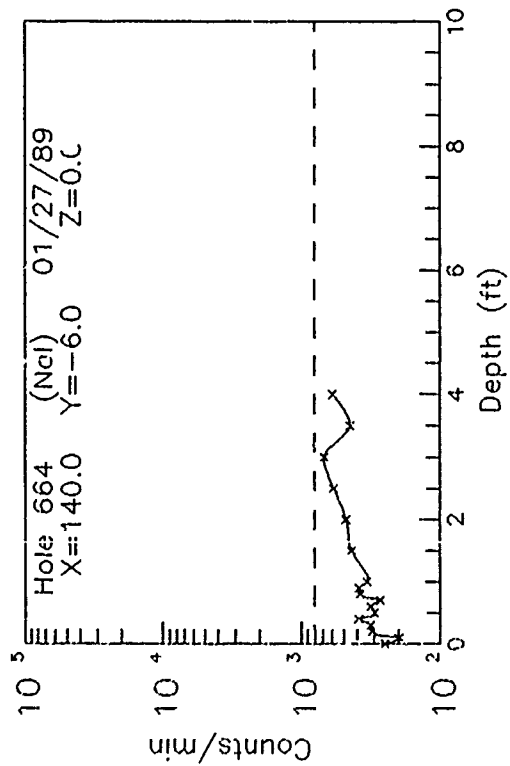
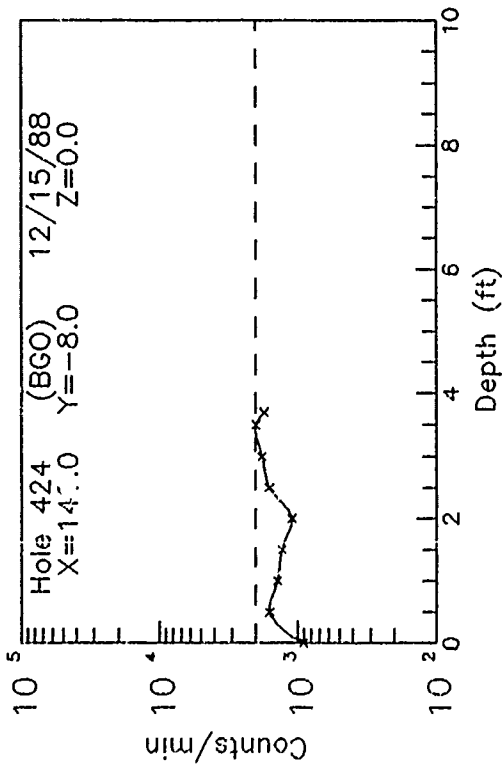
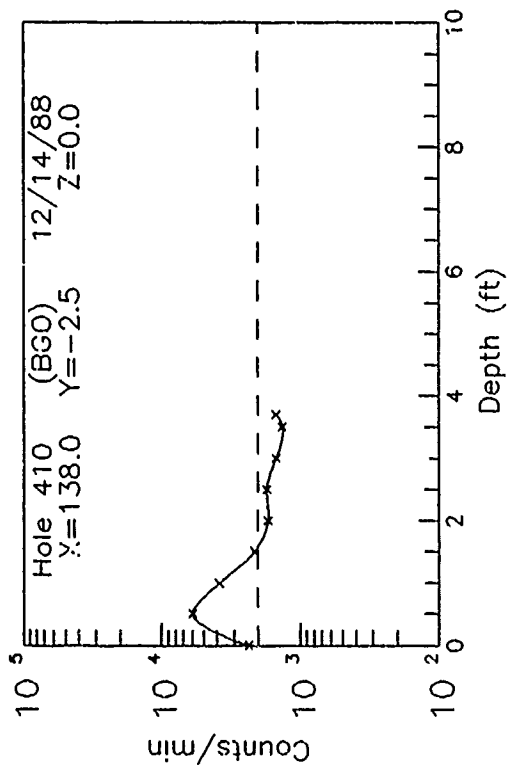
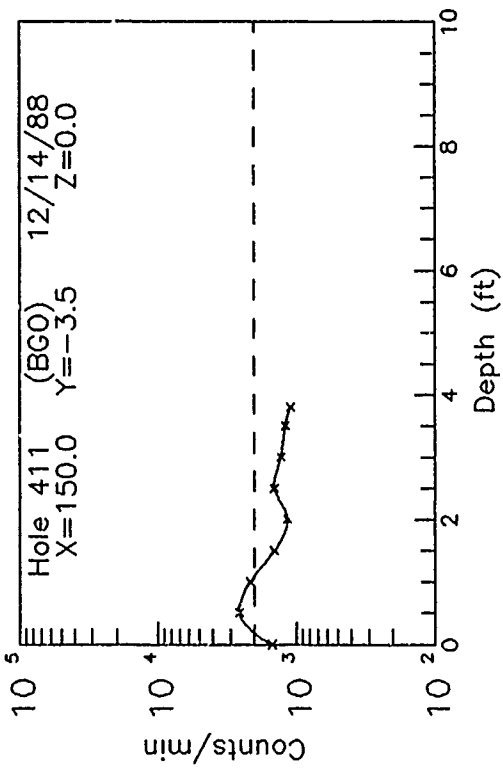


Figure C37. Subsurface Data from 60 Union in Map Region 26

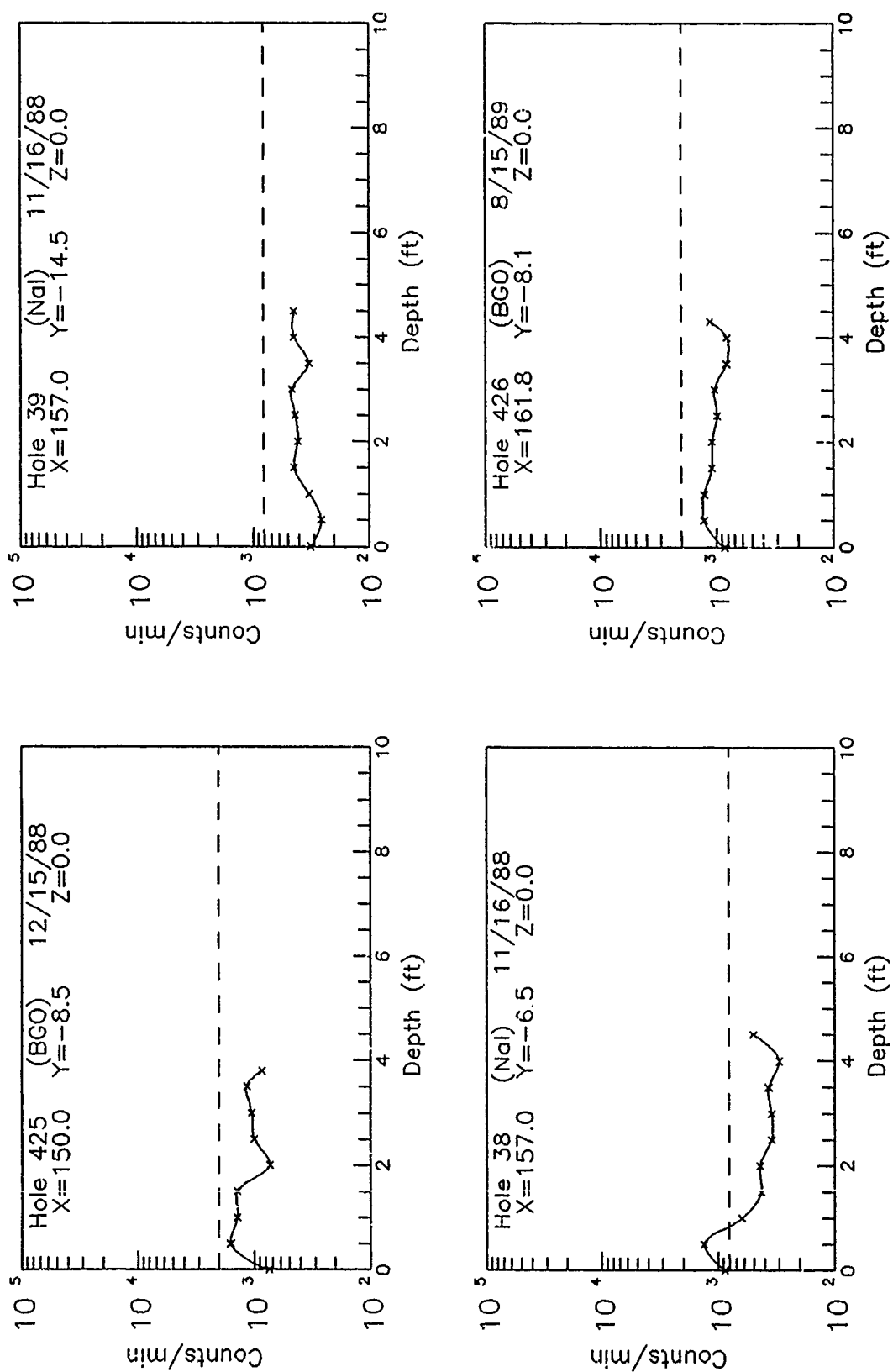


Figure C38. Subsurface Data from 60 Union in Map Region 27

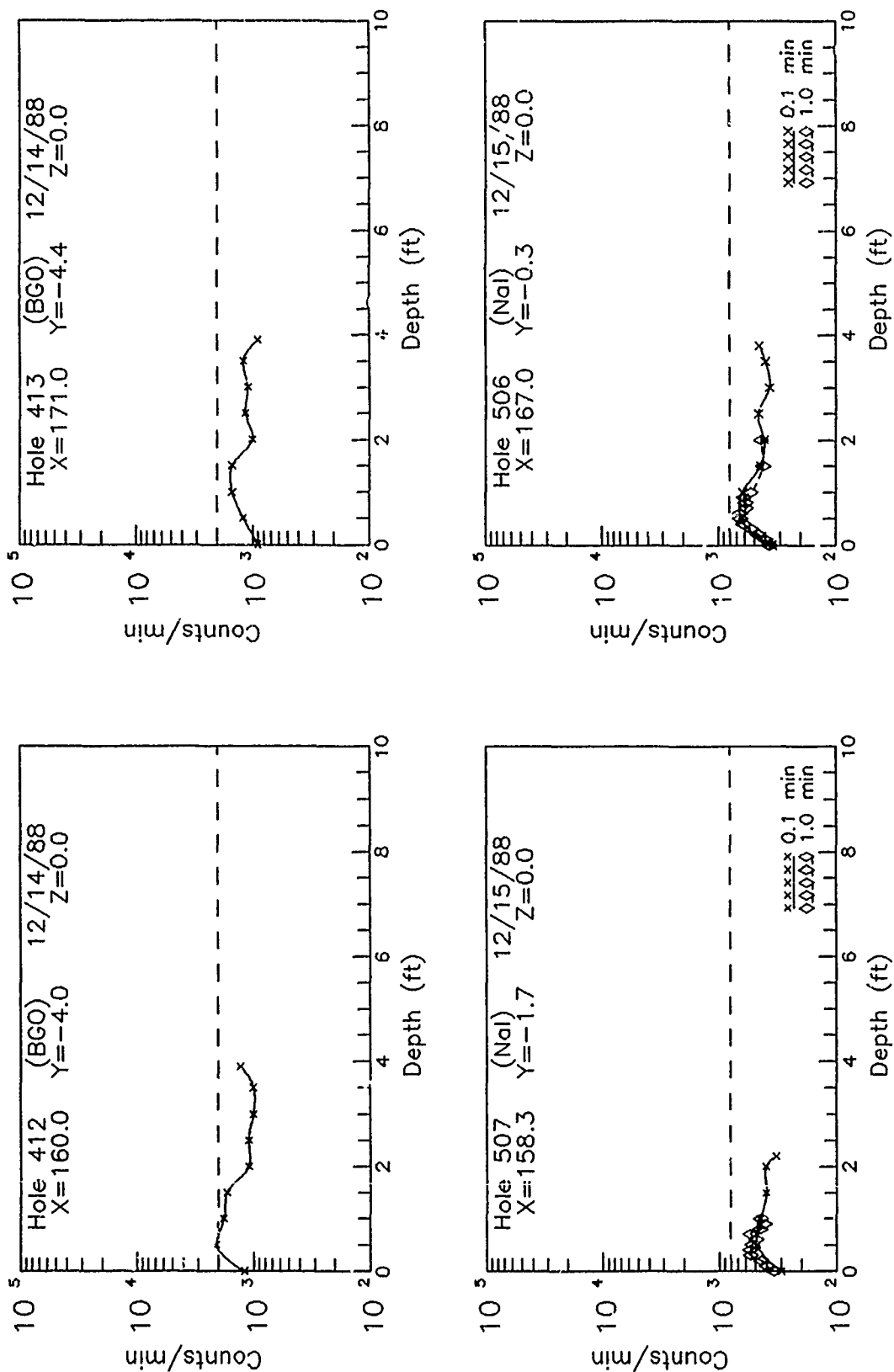


Figure C39. Subsurface Data from 60 Union and 115 Stratford in Map Region 28

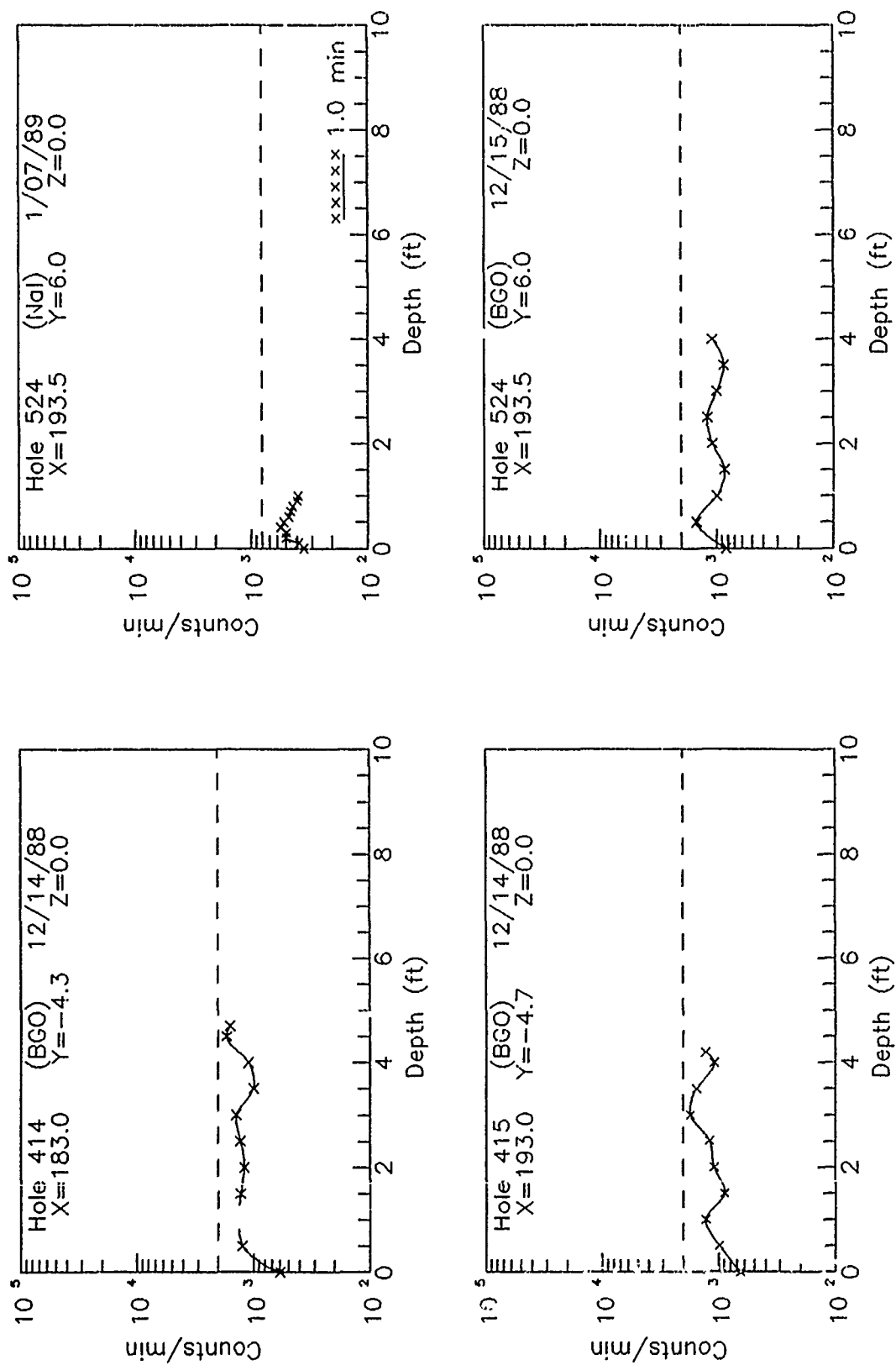


Figure C40. Subsurface Data from 60 Union and 115 Stratford in Map Region 29

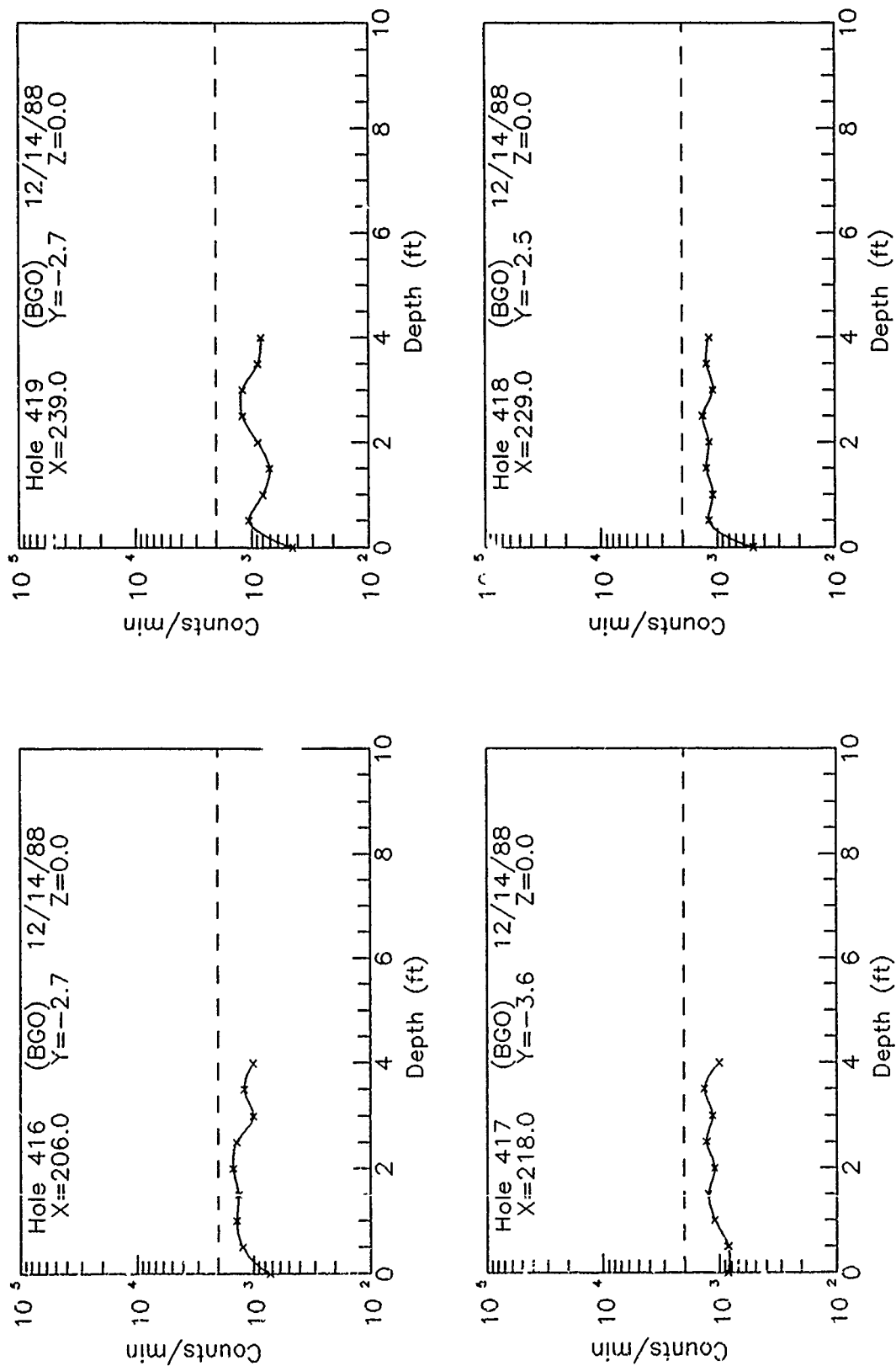


Figure C41. Subsurface Data from 60 Union in Map Region 30

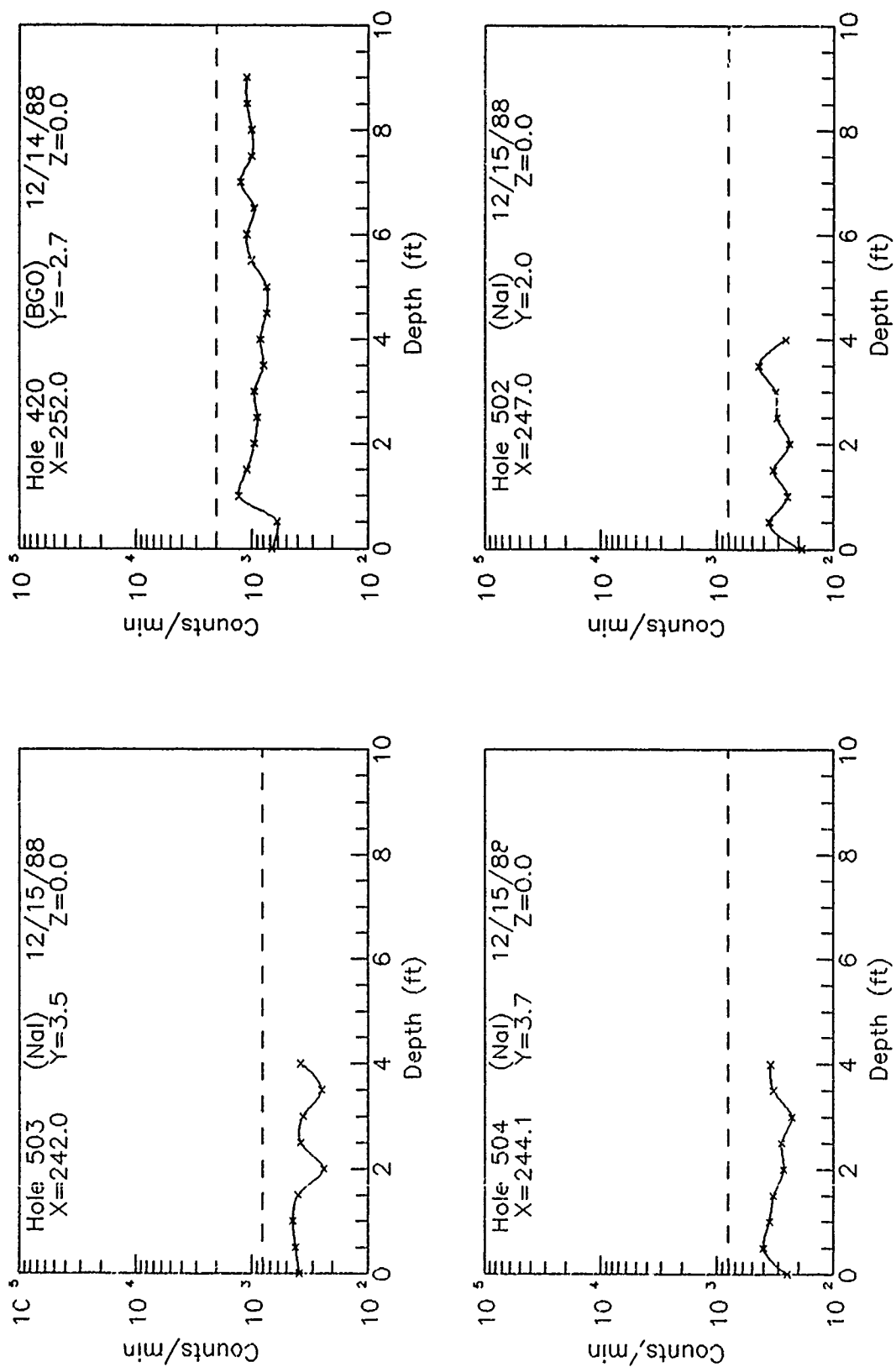


Figure C42. Subsurface Data from 60 Union and 121 E. Stratford in Map Region 31

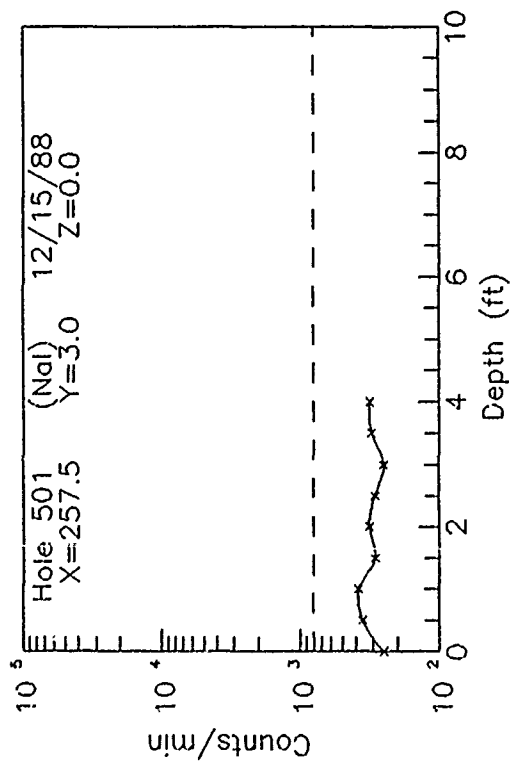
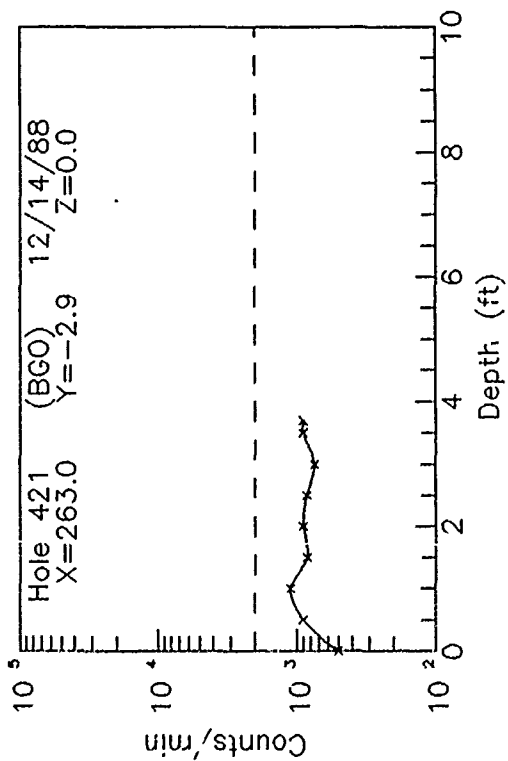
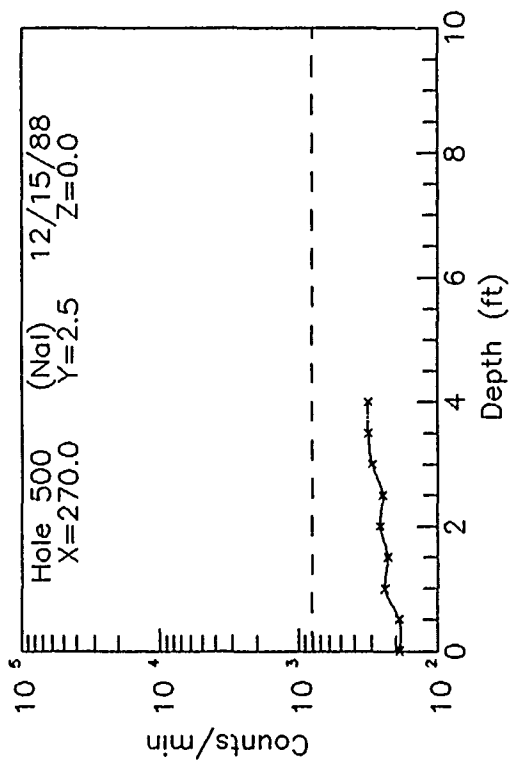
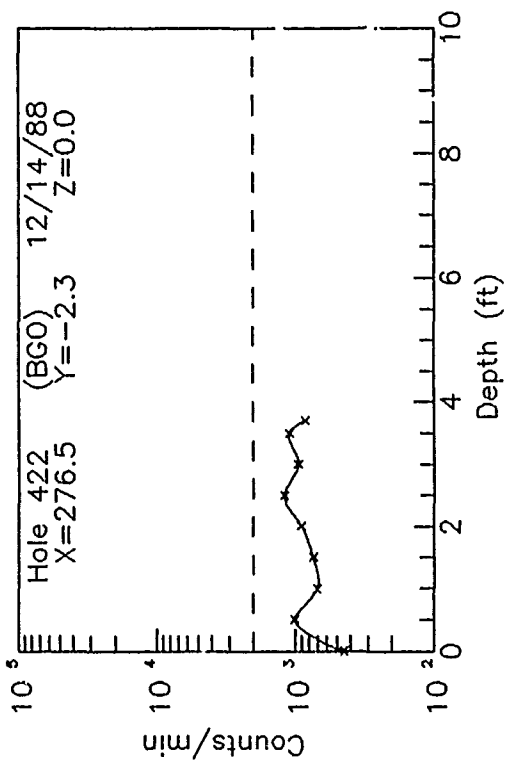


Figure C43. Subsurface Data from 60 Union and 121 E. Stratford in Map Region 32

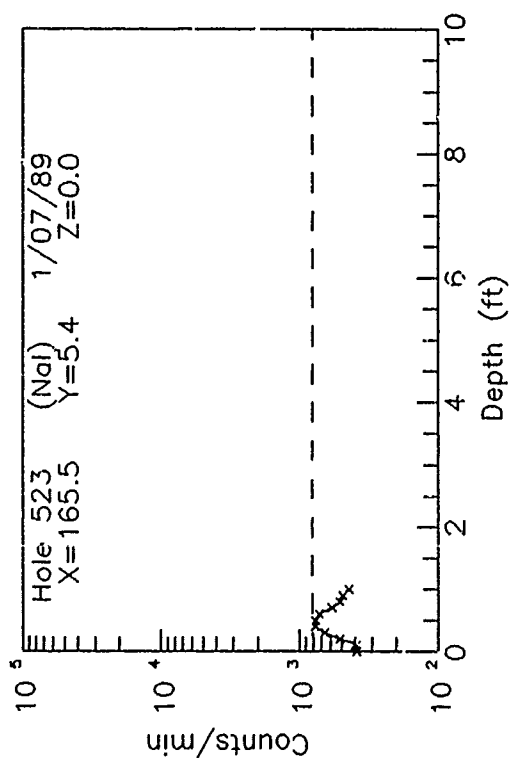
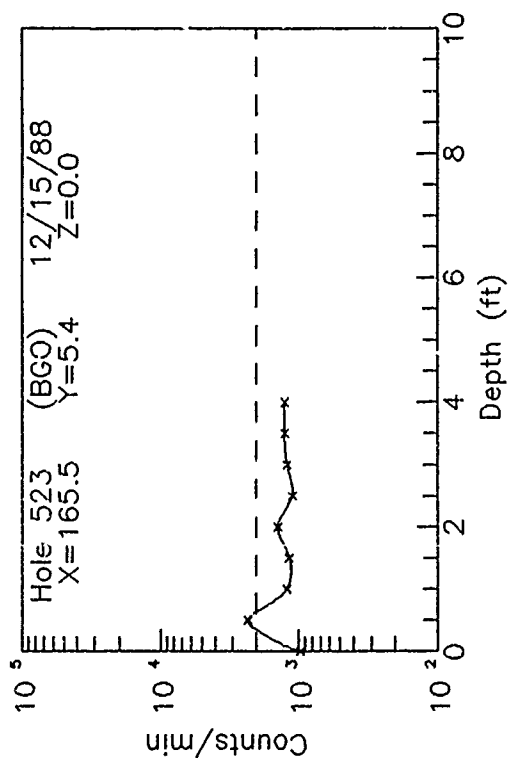
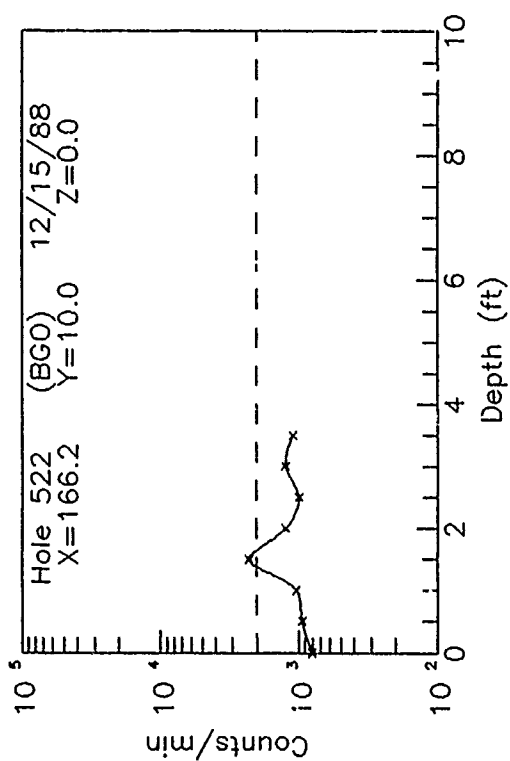
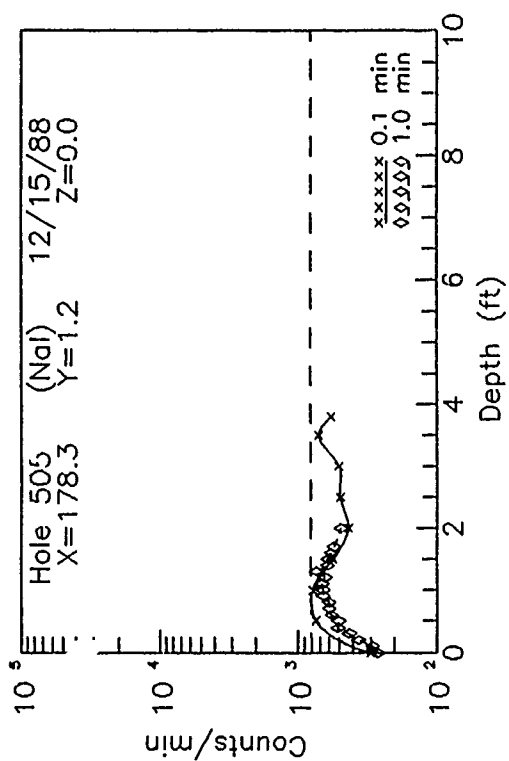


Figure C44. Subsurface Data from 115 E. Stratford in Map Region 33

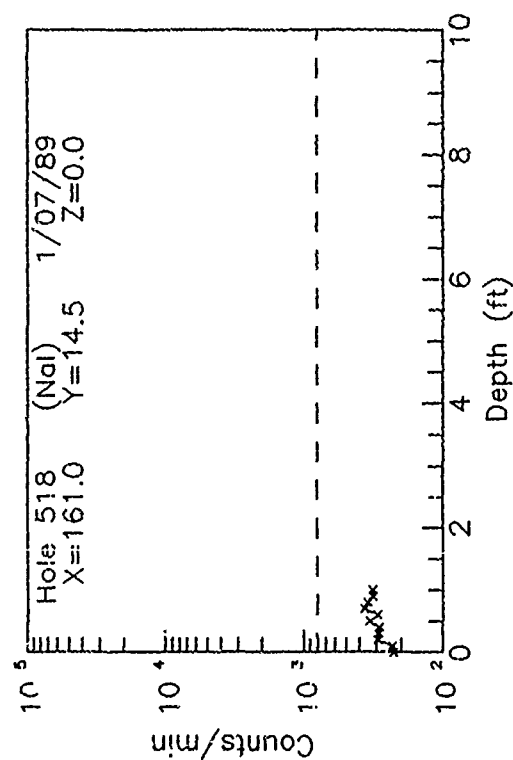
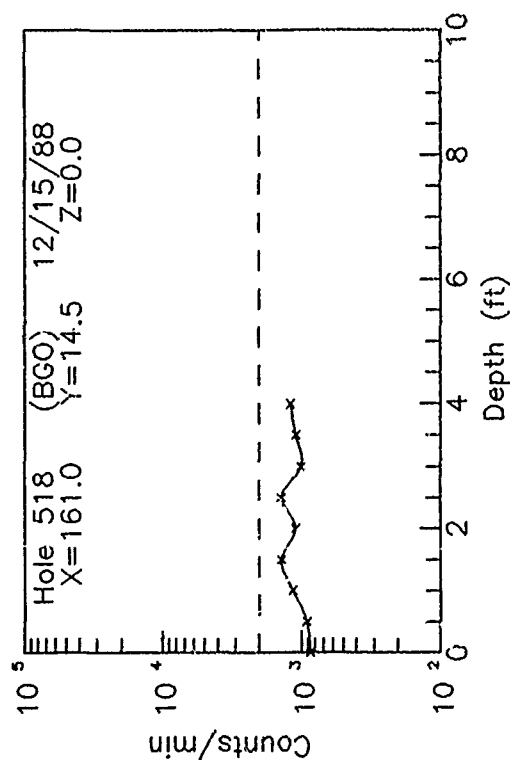
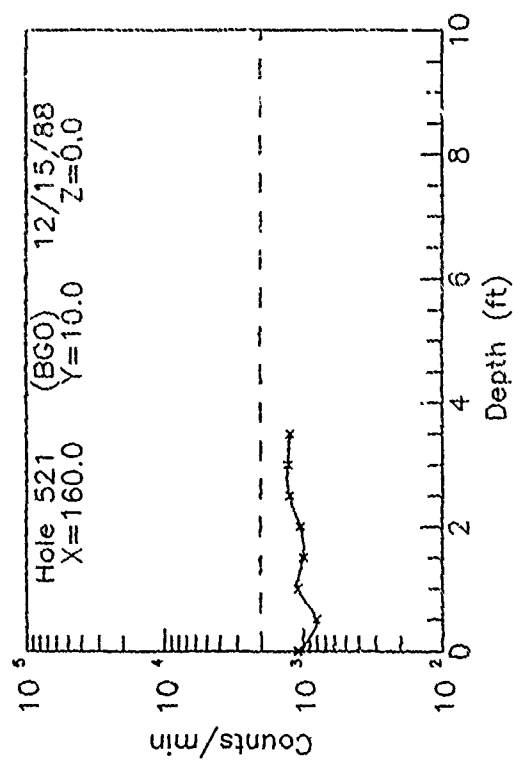
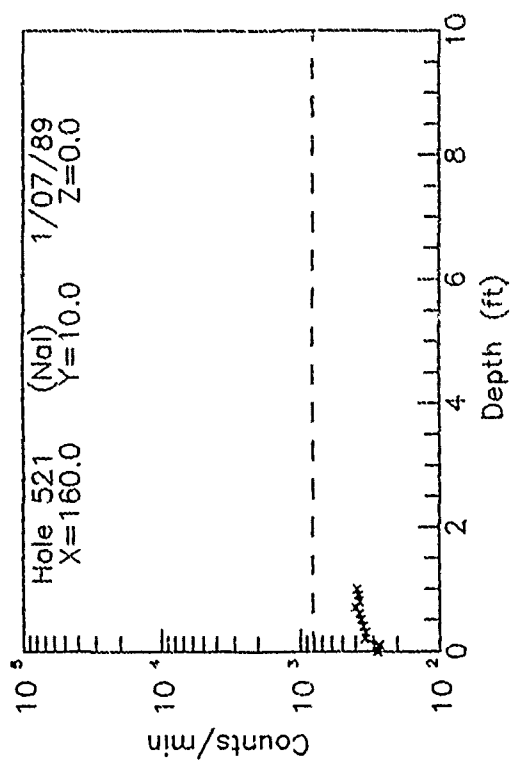


Figure C45. Subsurface Data from 115 E. Stratford in Map Region 34

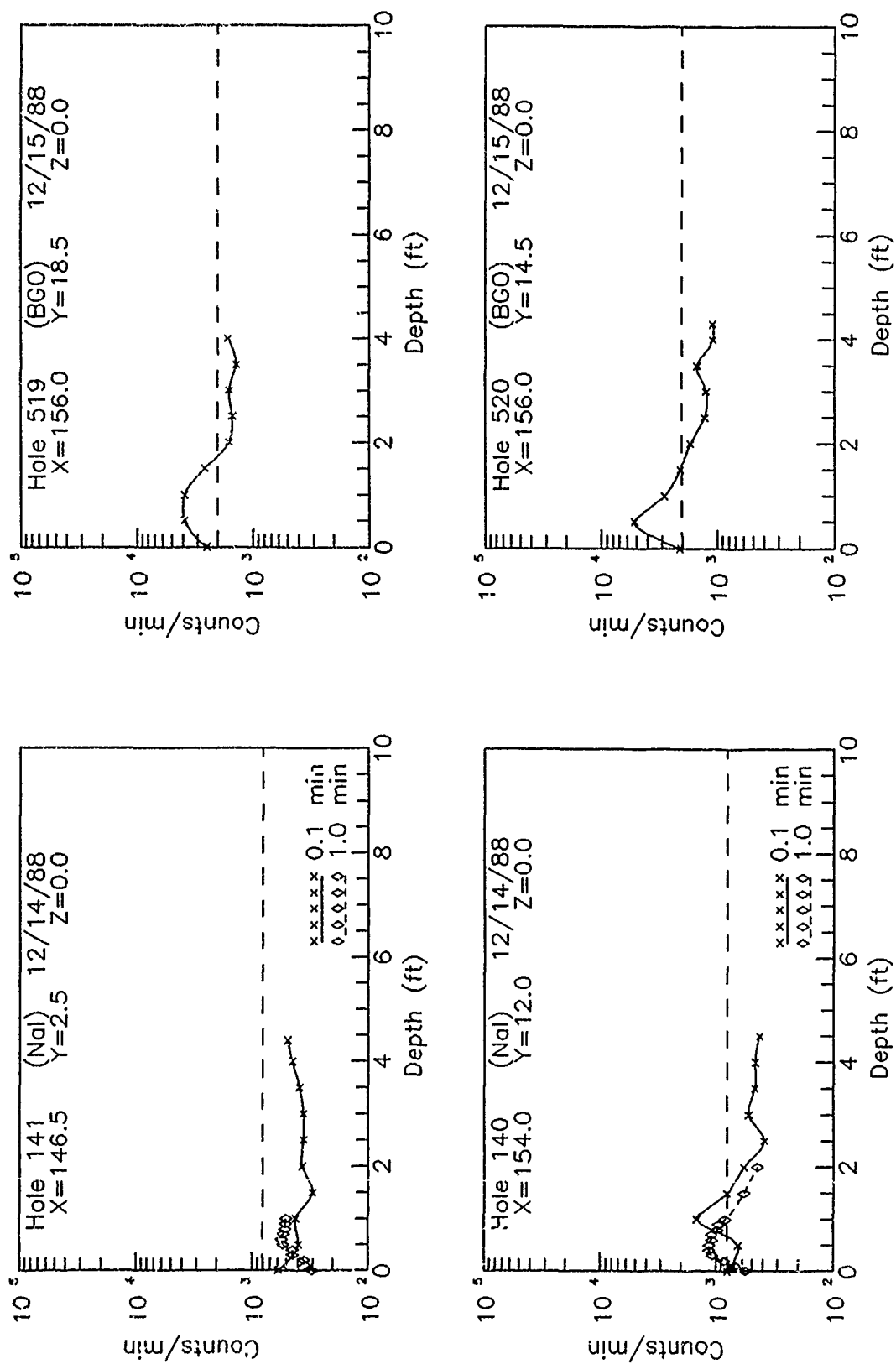


Figure C46. Subsurface Data from 107 and 115 E. Stratford in Map Region 35

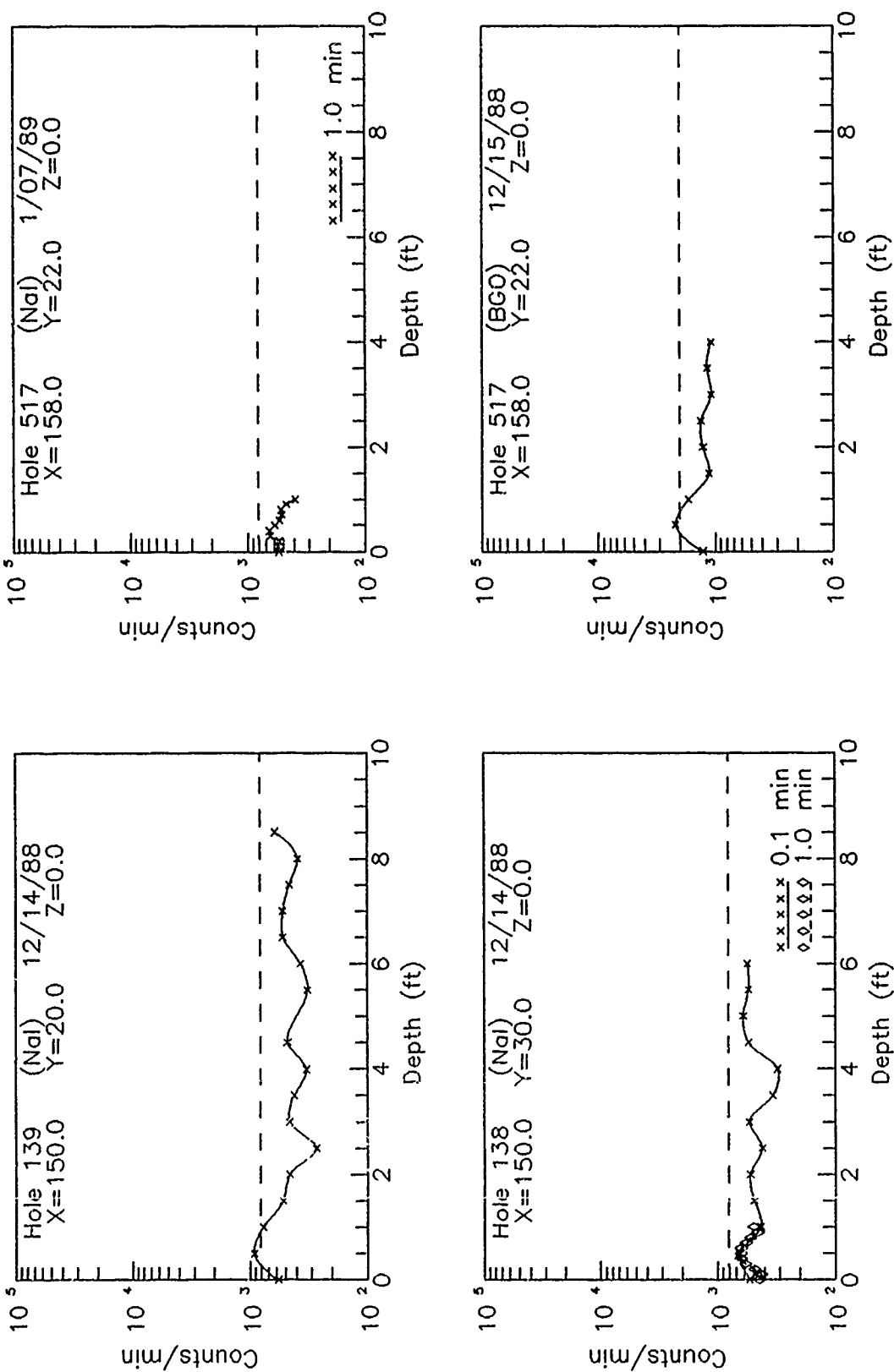


Figure C47. Subsurface Data from 107 and 115 E. Stratford in Map Region 36

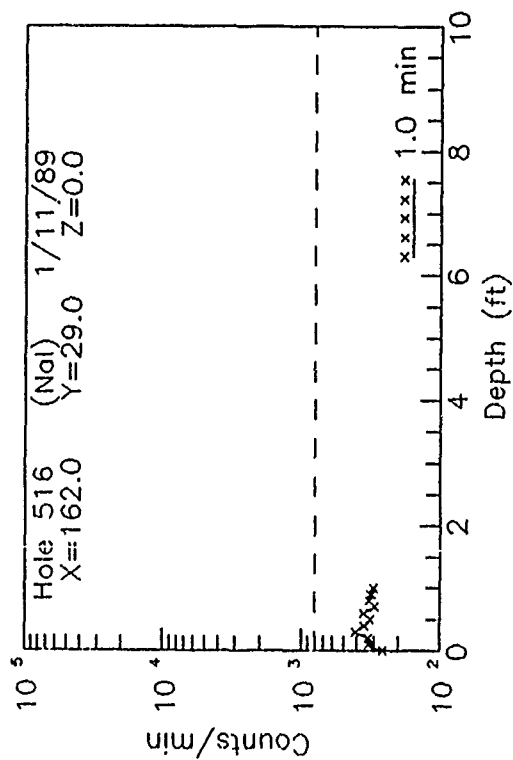
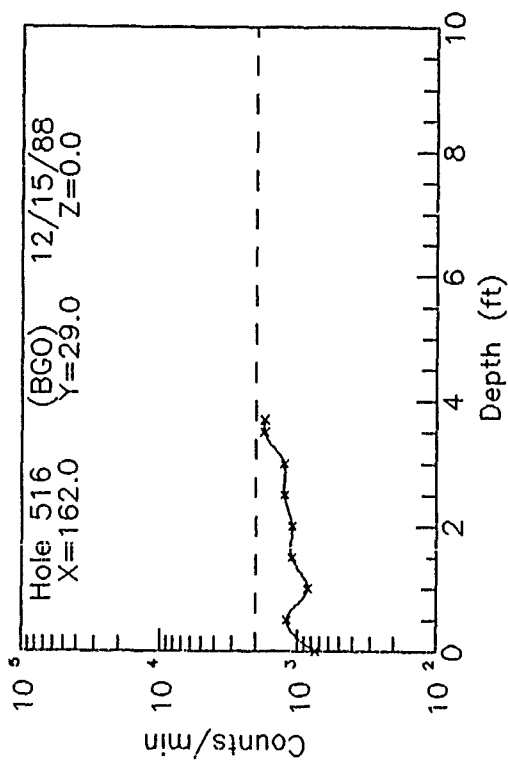
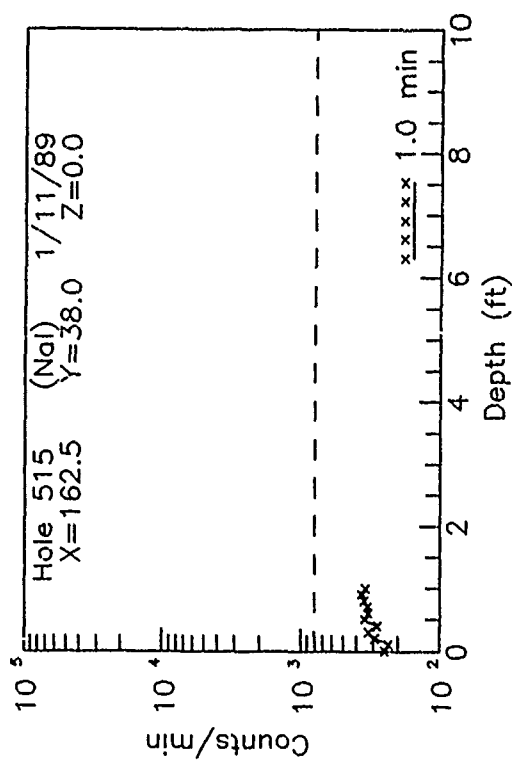
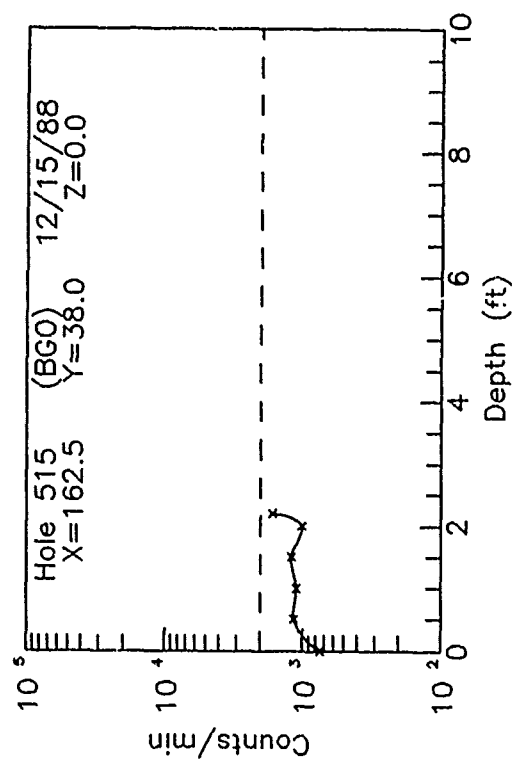


Figure C48. Subsurface Data from 115 E. Stratford in Map Region 37

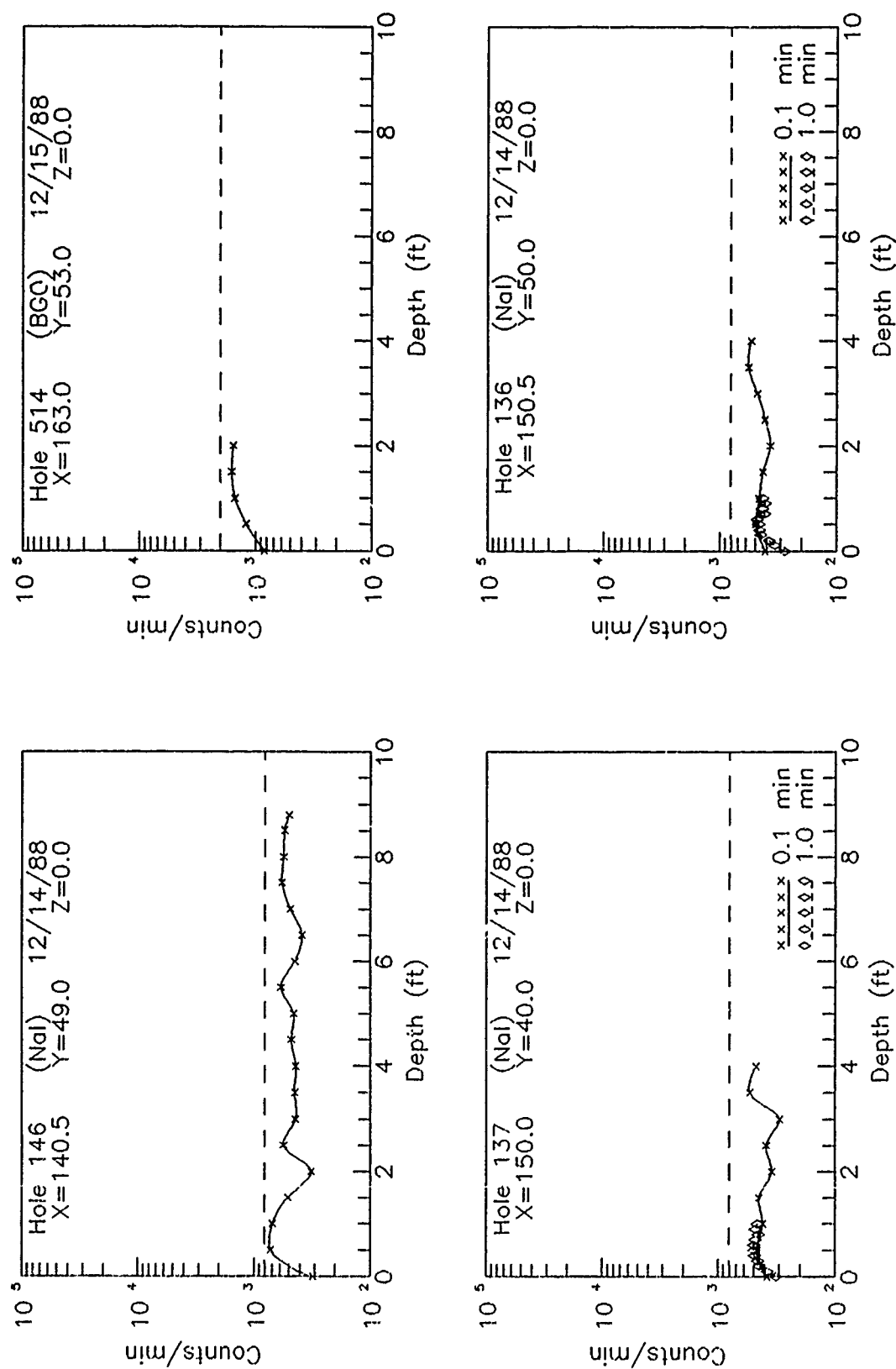


Figure C49. Subsurface Data from 107 and 115 E. Stratford in Map Region 38

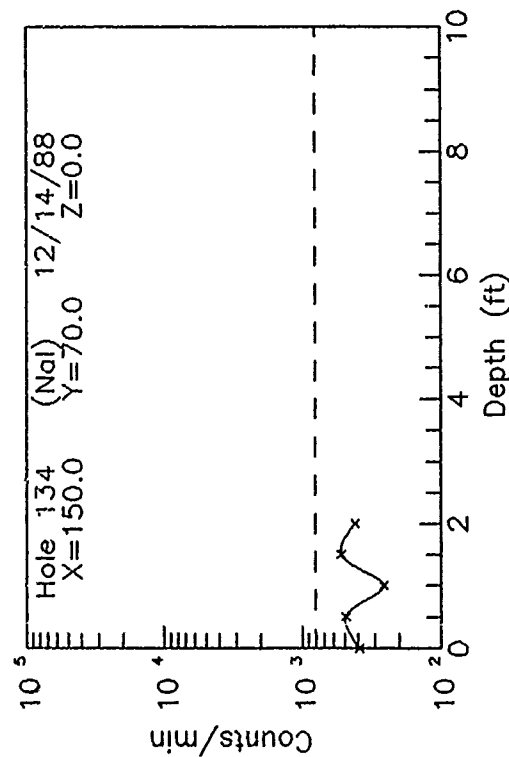
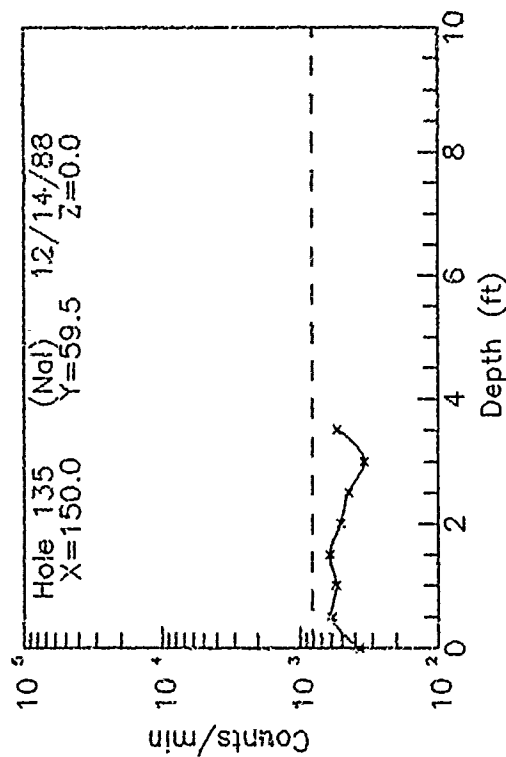
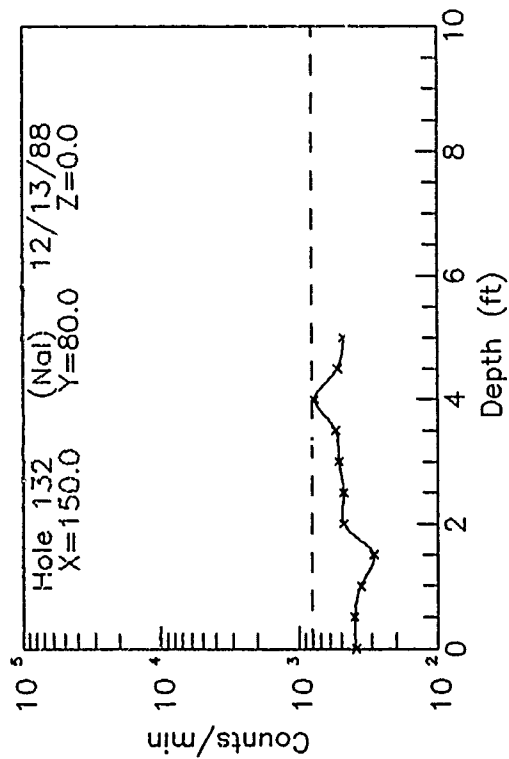
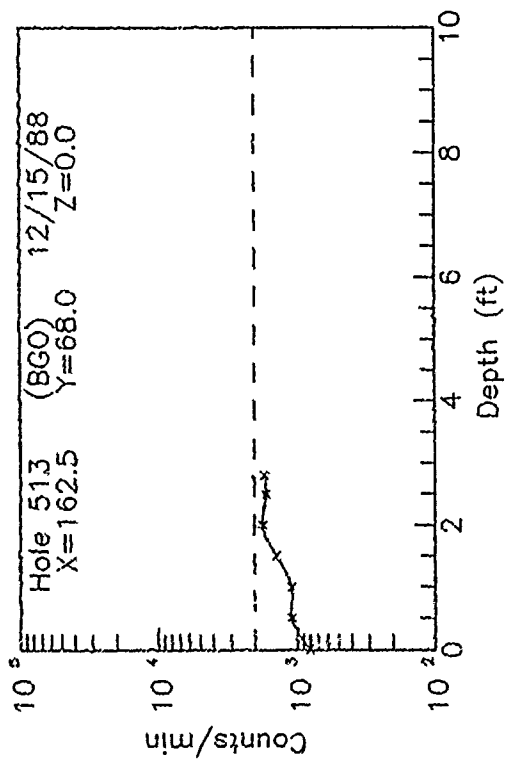


Figure C50. Subsurface Data from 107 and 115 E. Stratford in Map Region 39

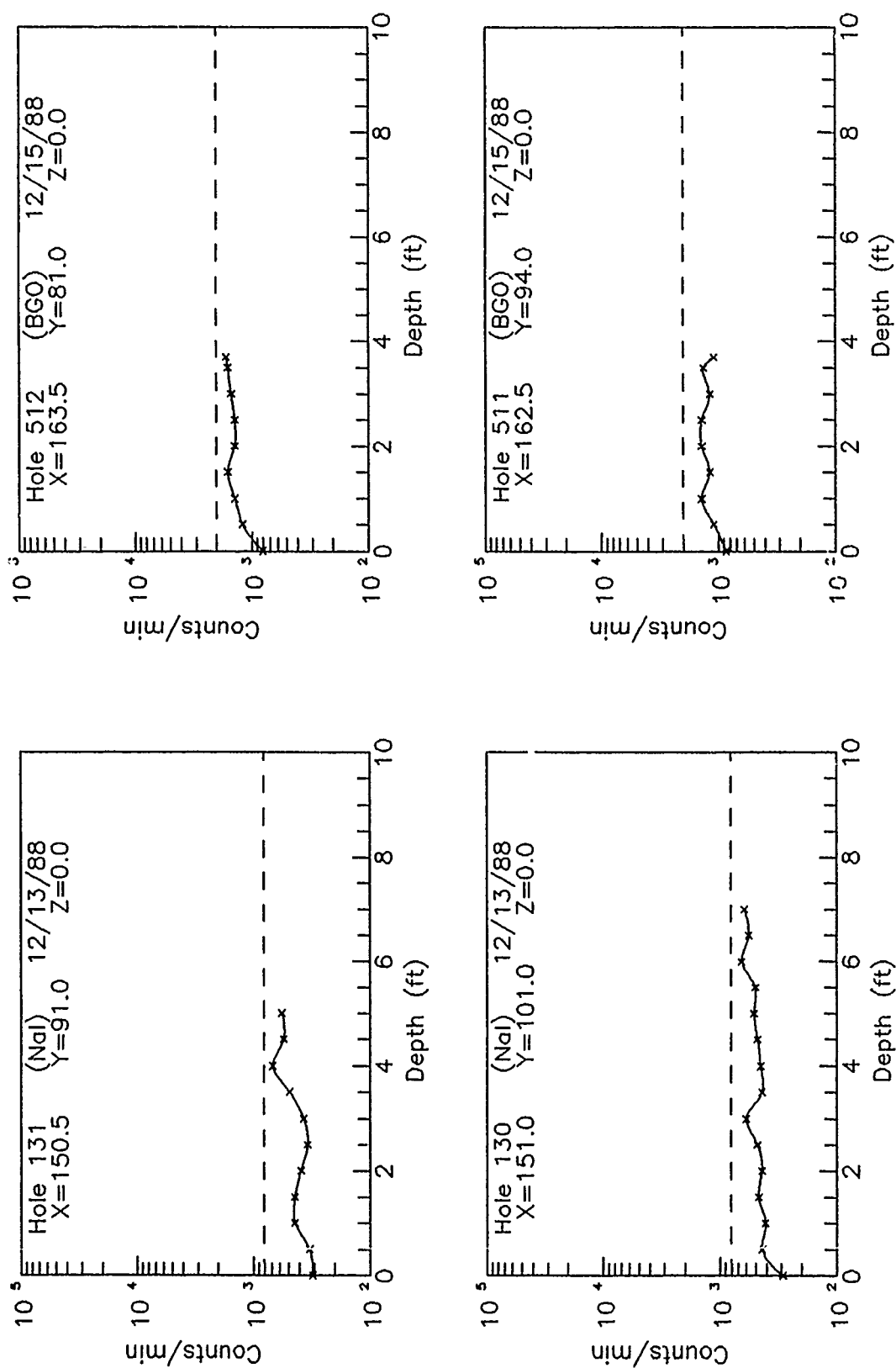


Figure C51. Subsurface Data from 107 and 115 E. Stratford in Map Region 40

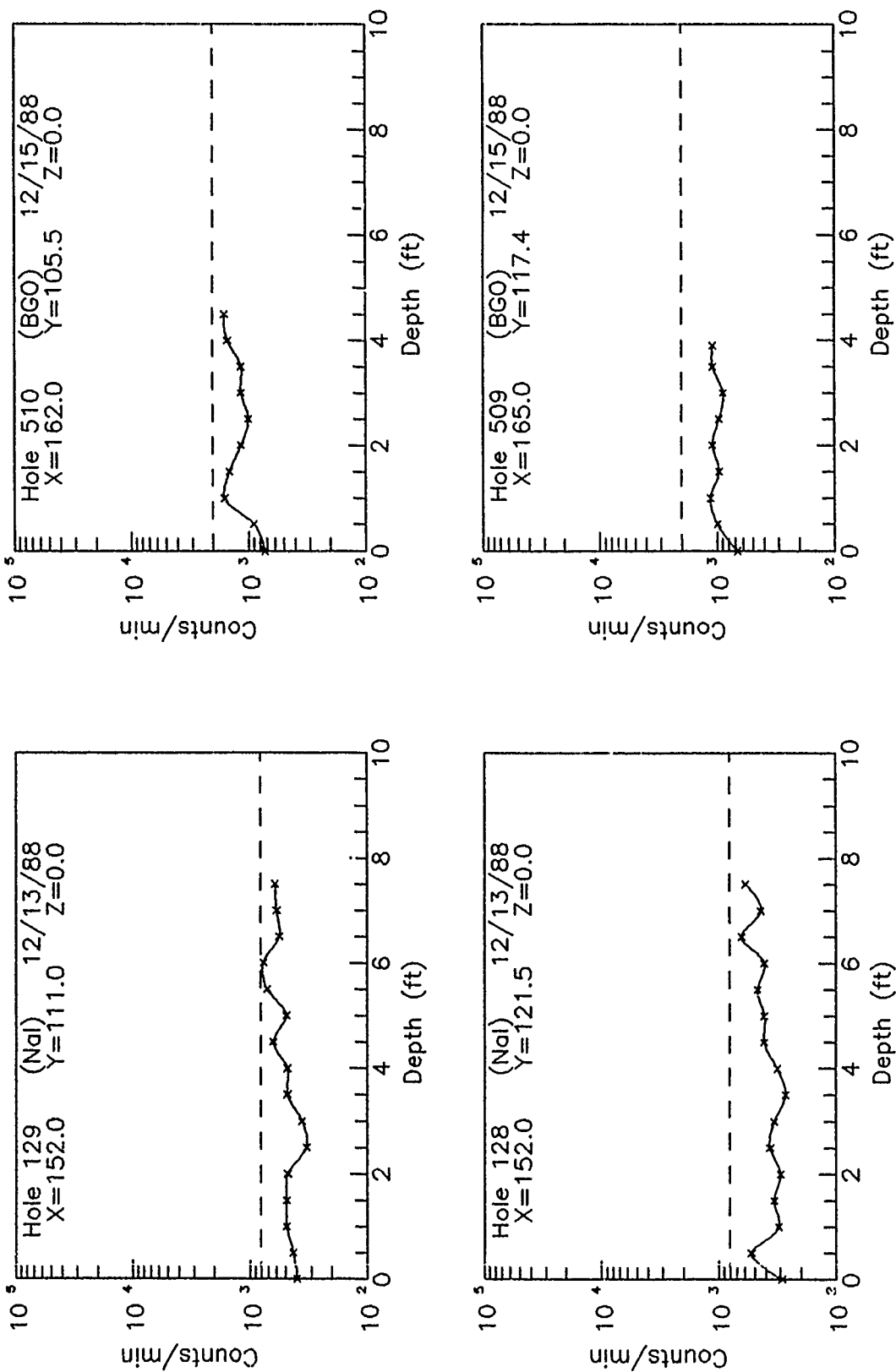


Figure C52. Subsurface Data from 107 and 115 E. Stratford in Map Region 41

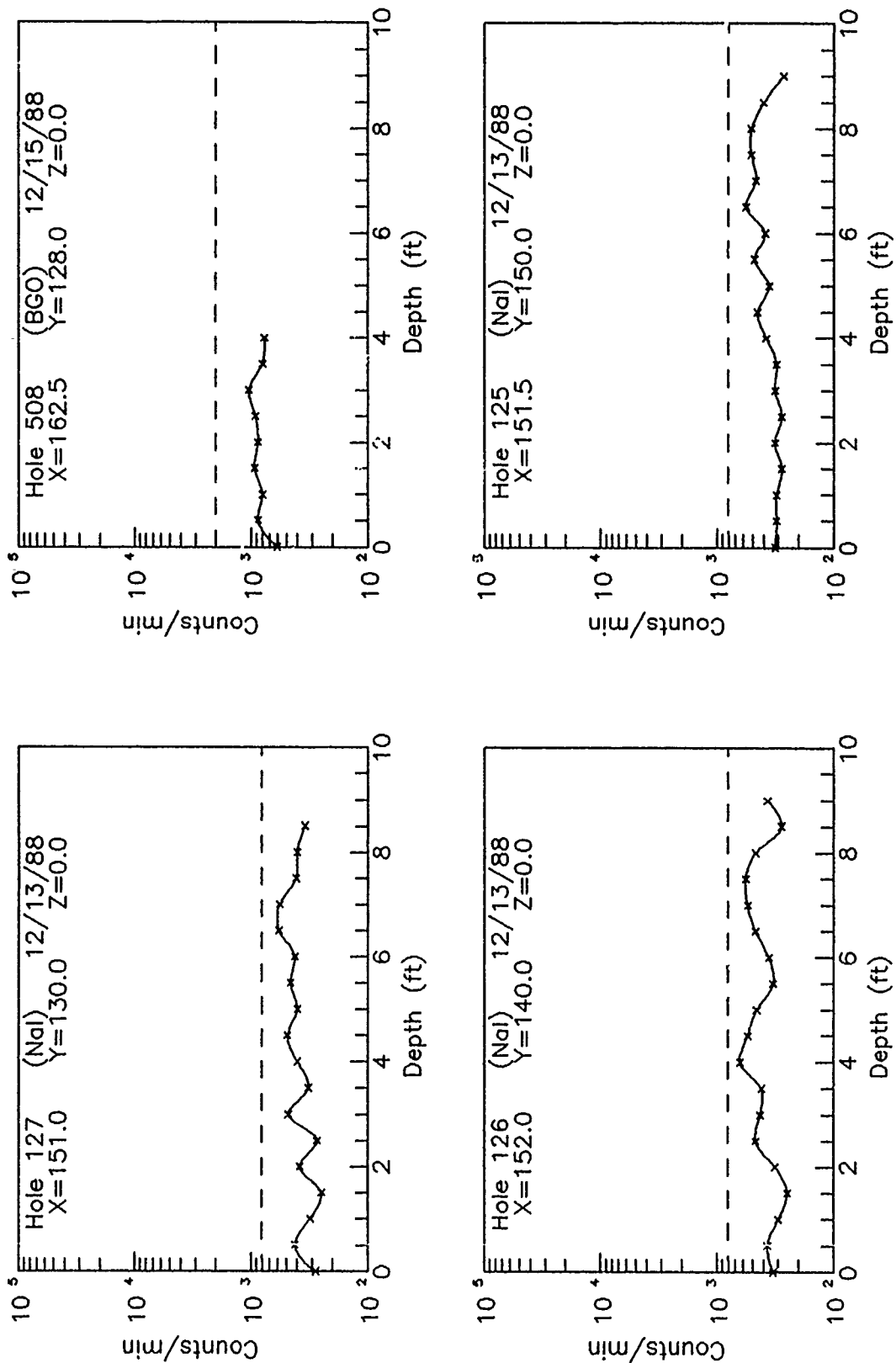


Figure C53. Subsurface Data from 107 and 115 E. Stratford in Map Region 42

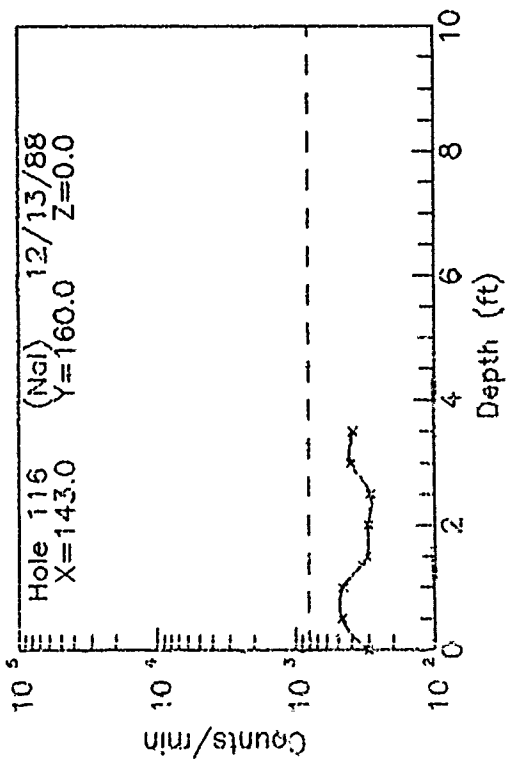
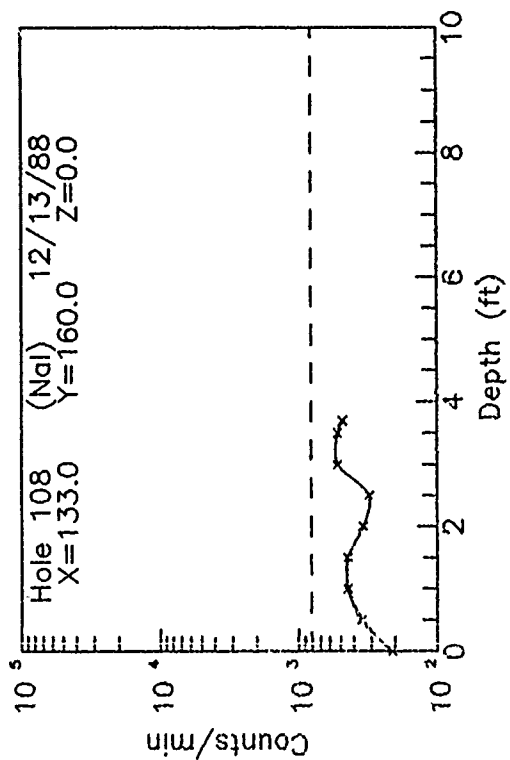
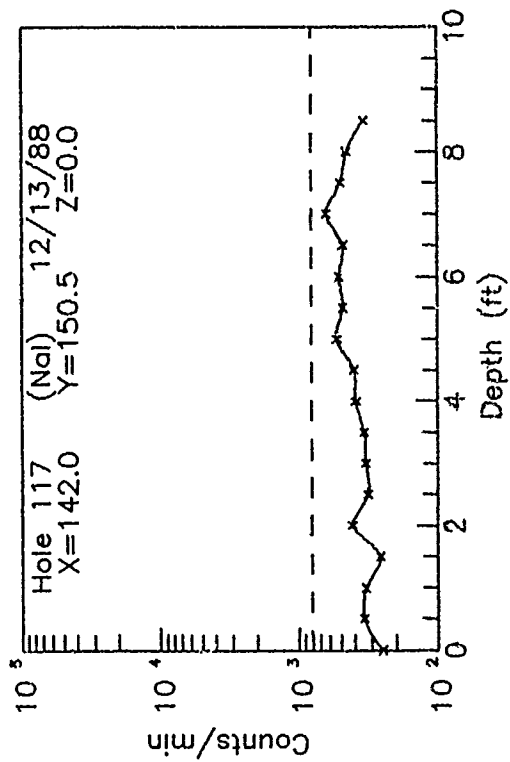
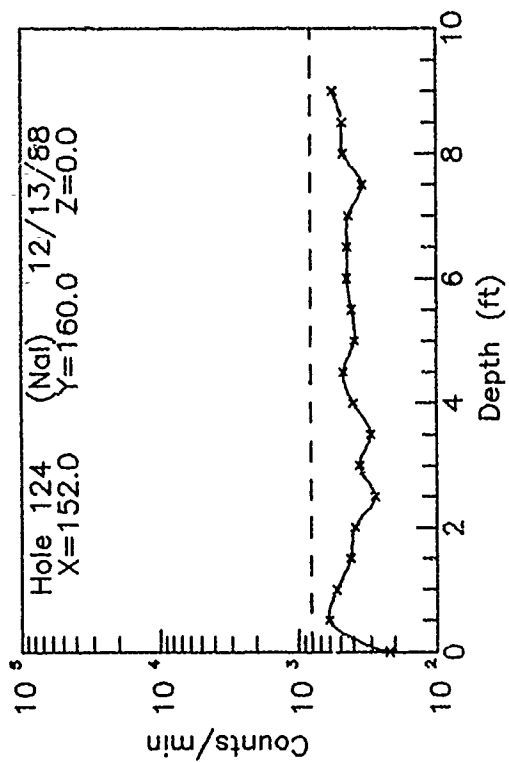


Figure C54. Subsurface Data from 107 E. Stratford in Map Region 43

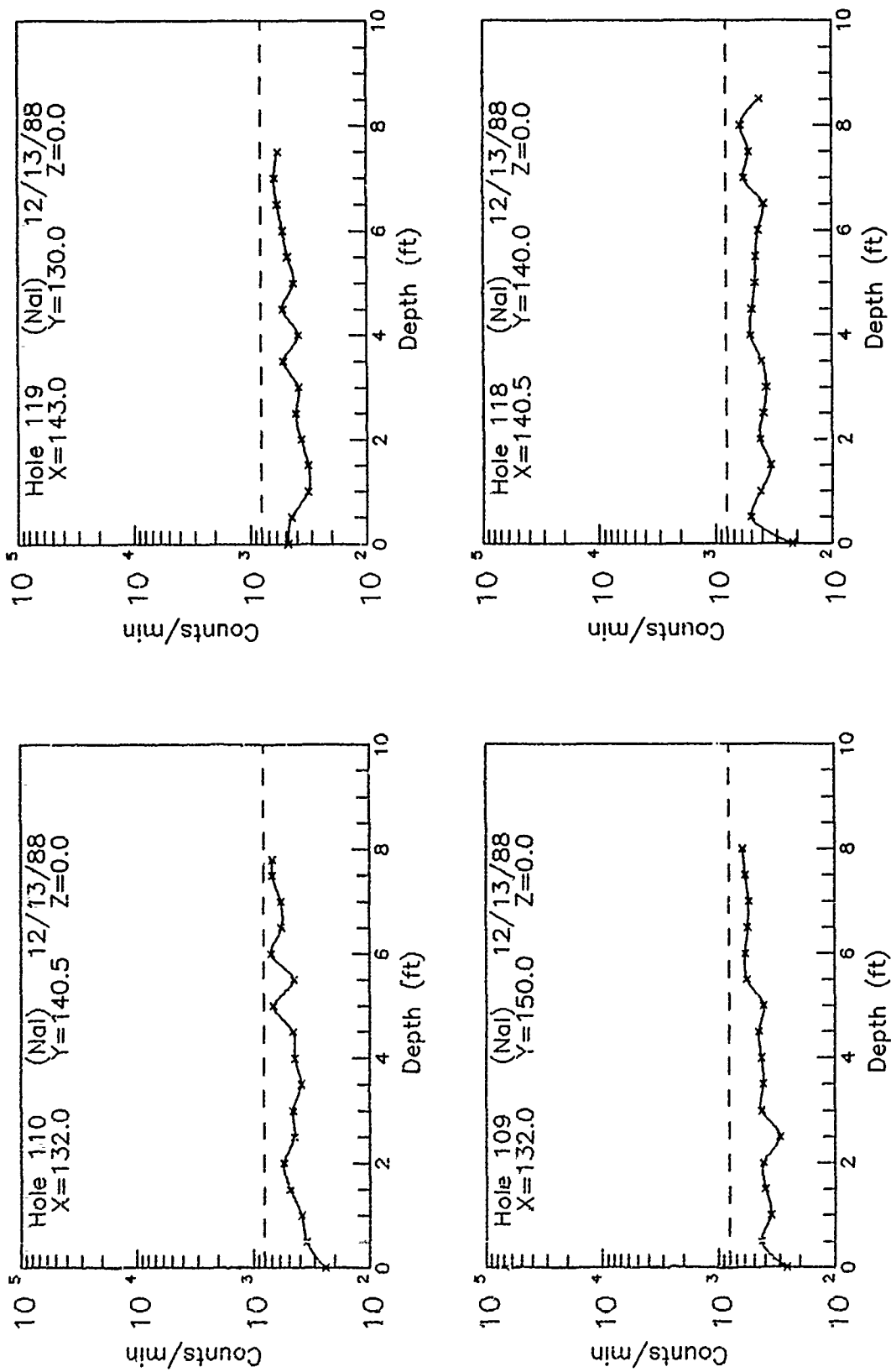


Figure C55. Subsurface Data from 107 E. Stratford in Map Region 44

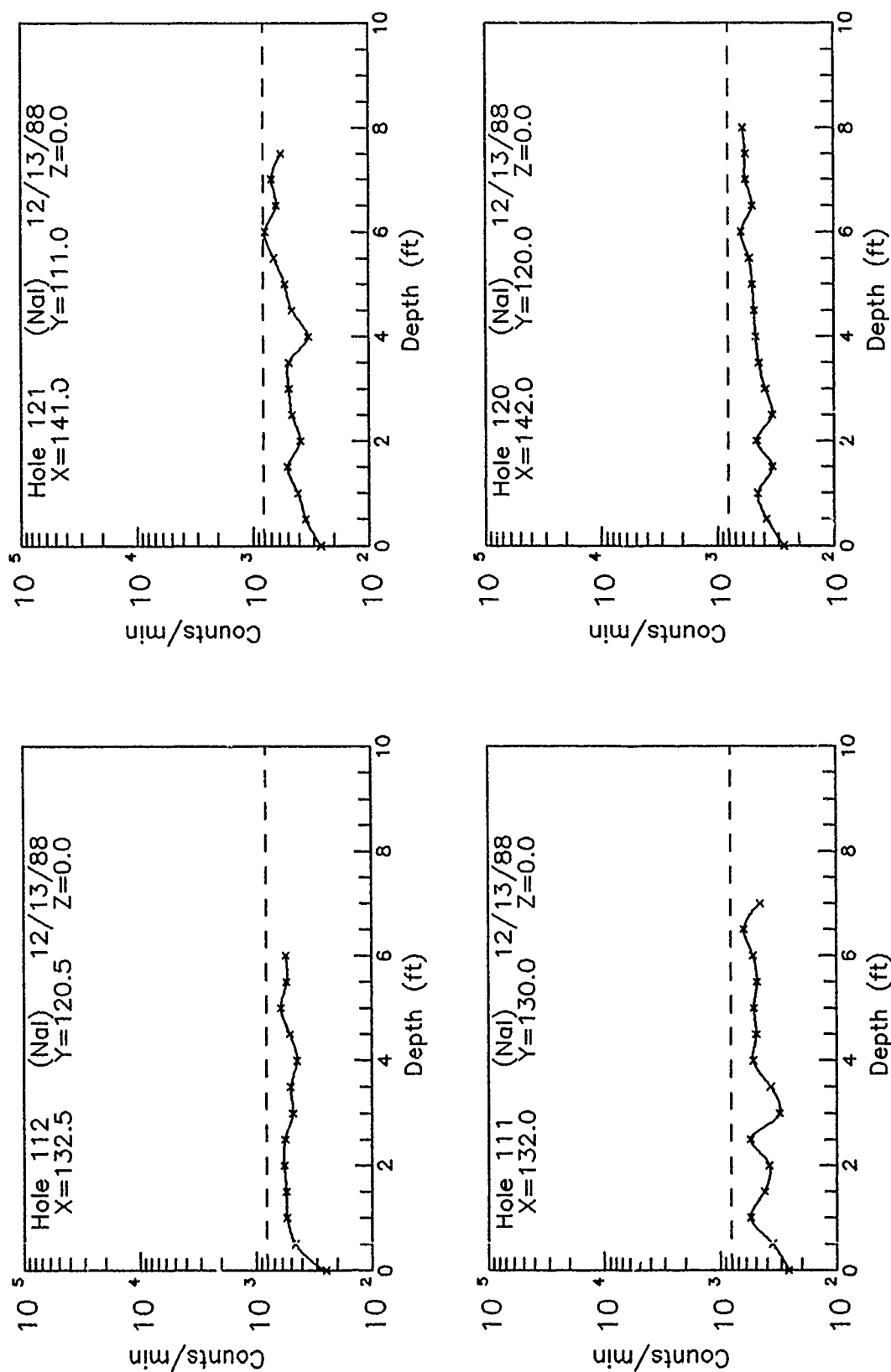


Figure C56. Subsurface Data from 107 E. Stratford in Map Region 45

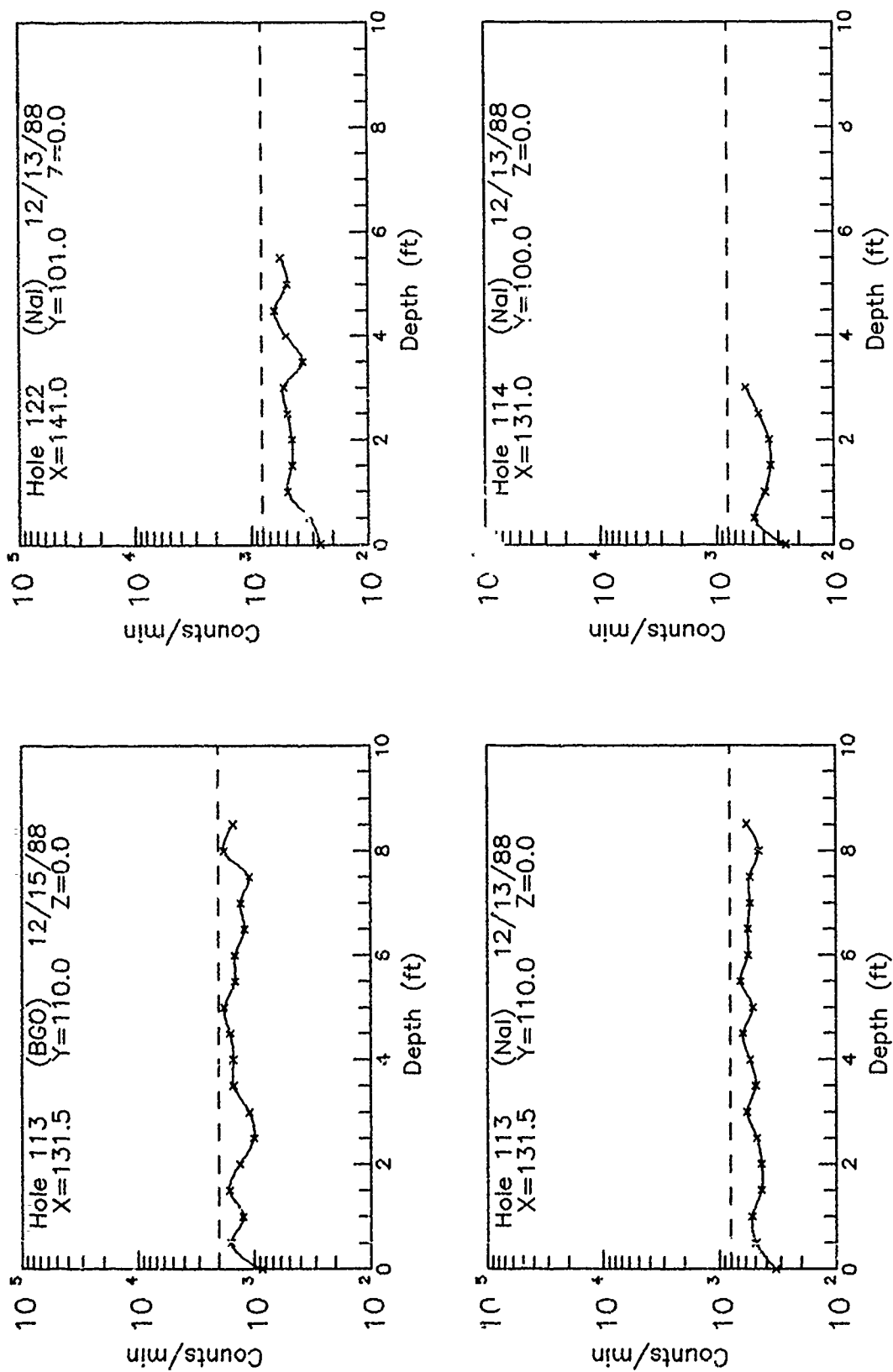


Figure C57. Subsurface Data from 107 E. Stratford in Map Region 46

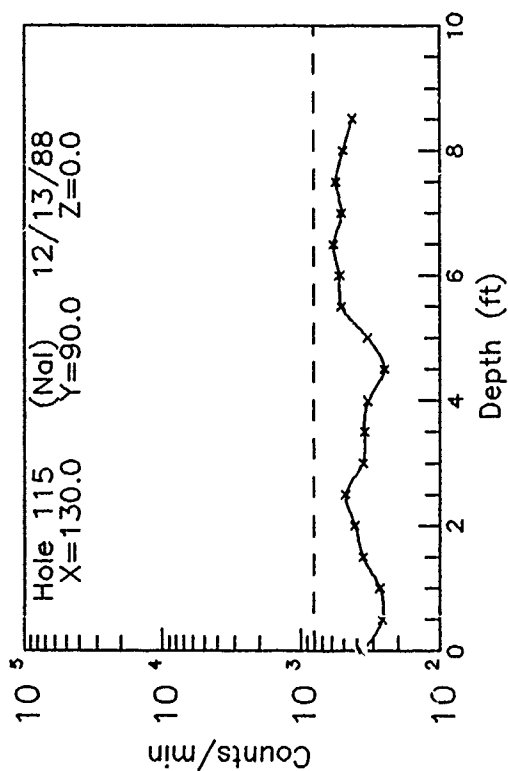
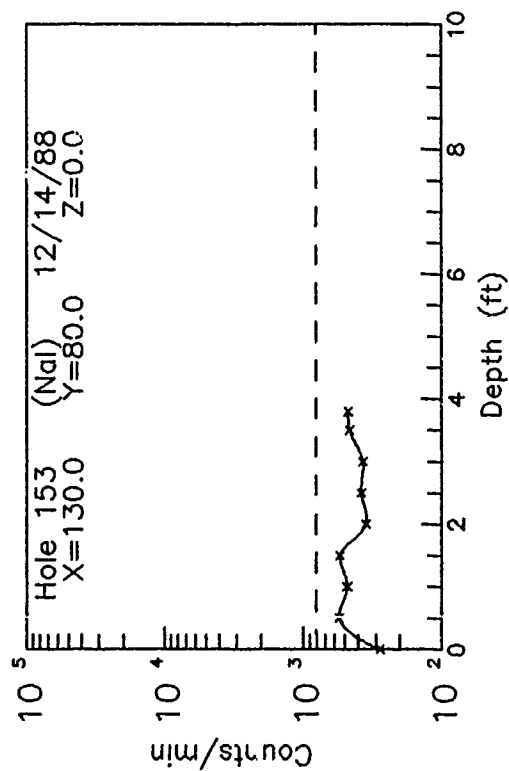
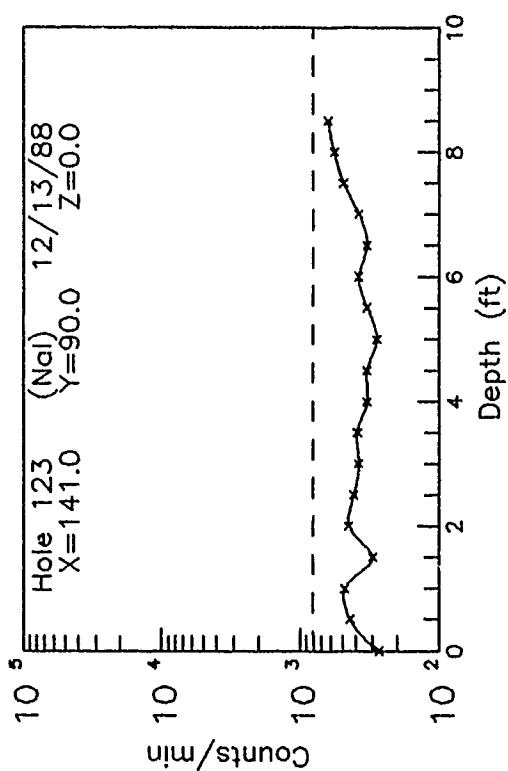
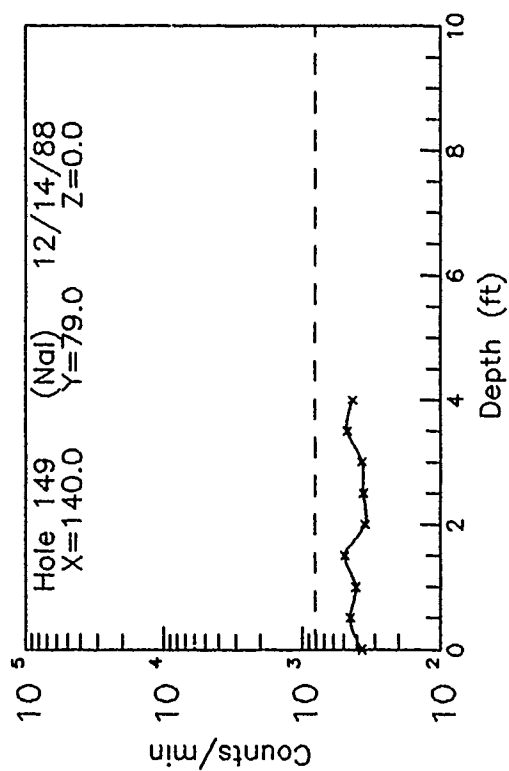


Figure C58. Subsurface Data from 107 E. Stratford in Map Region 47

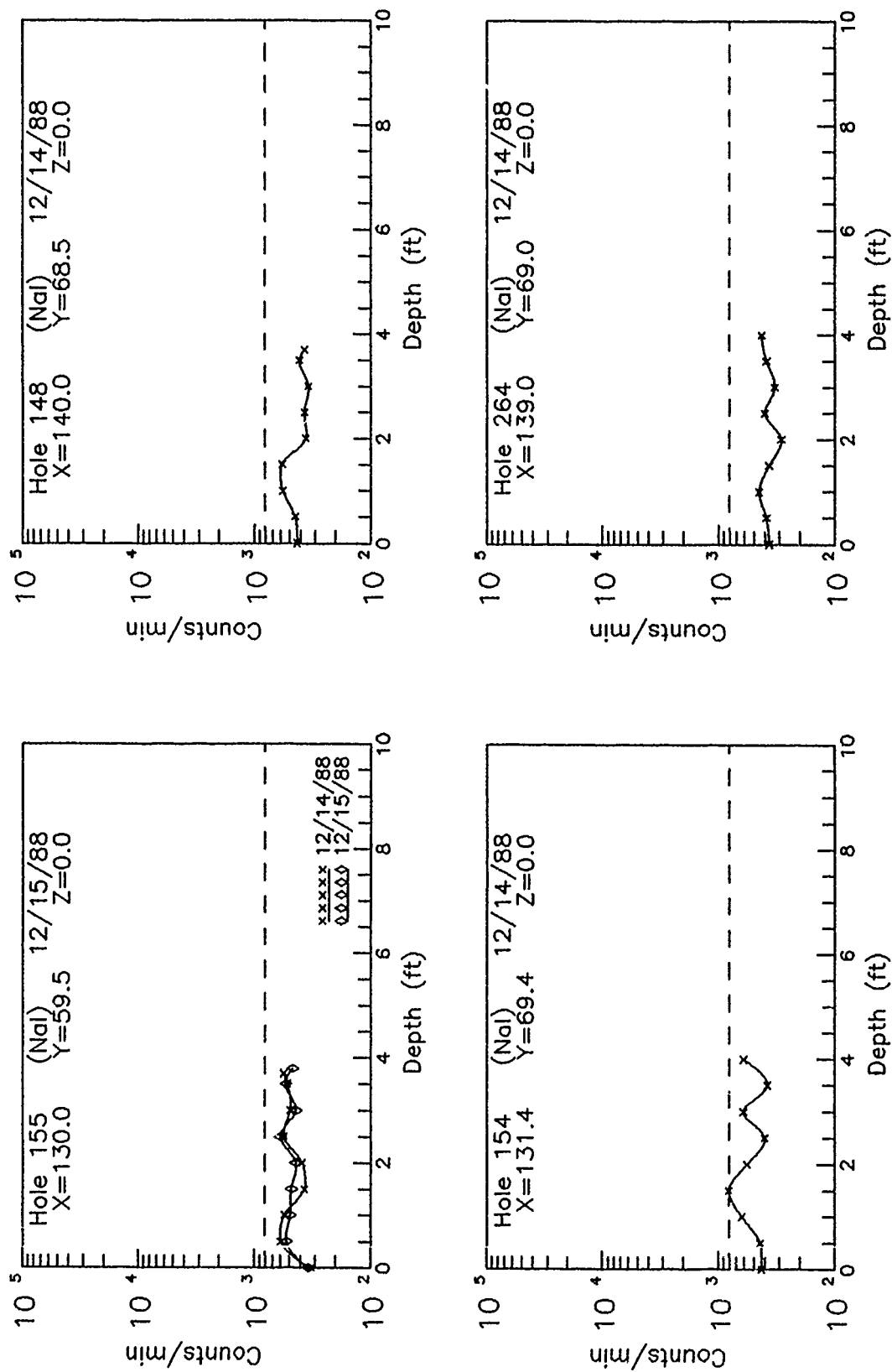


Figure C59. Subsurface Data from 107 E. Stratford in Map Region 48

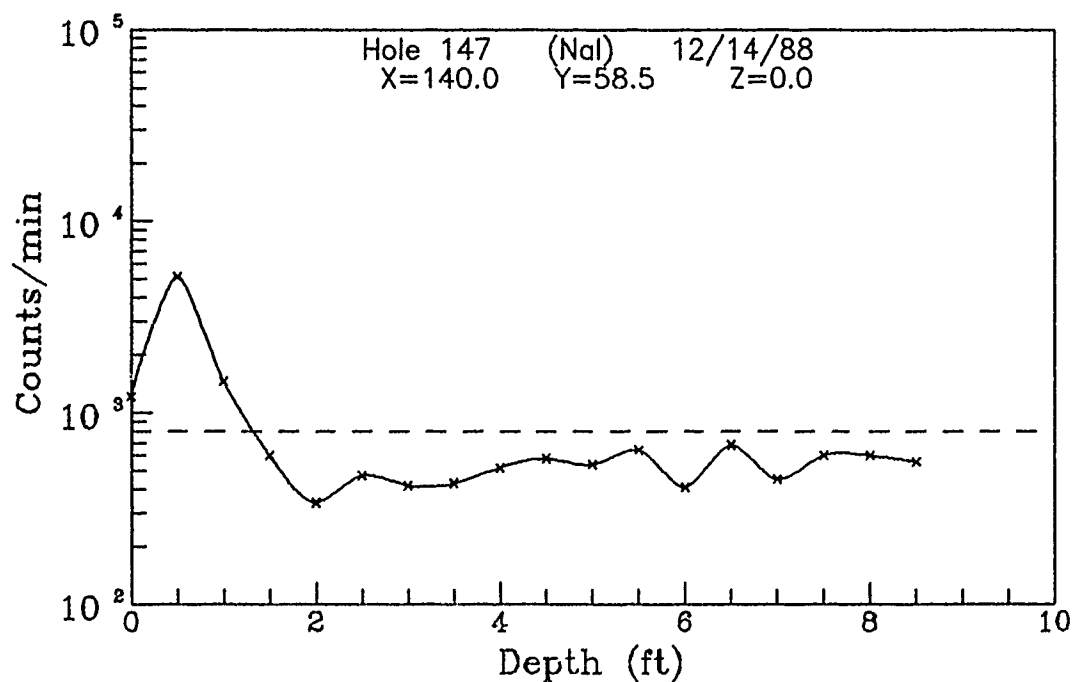
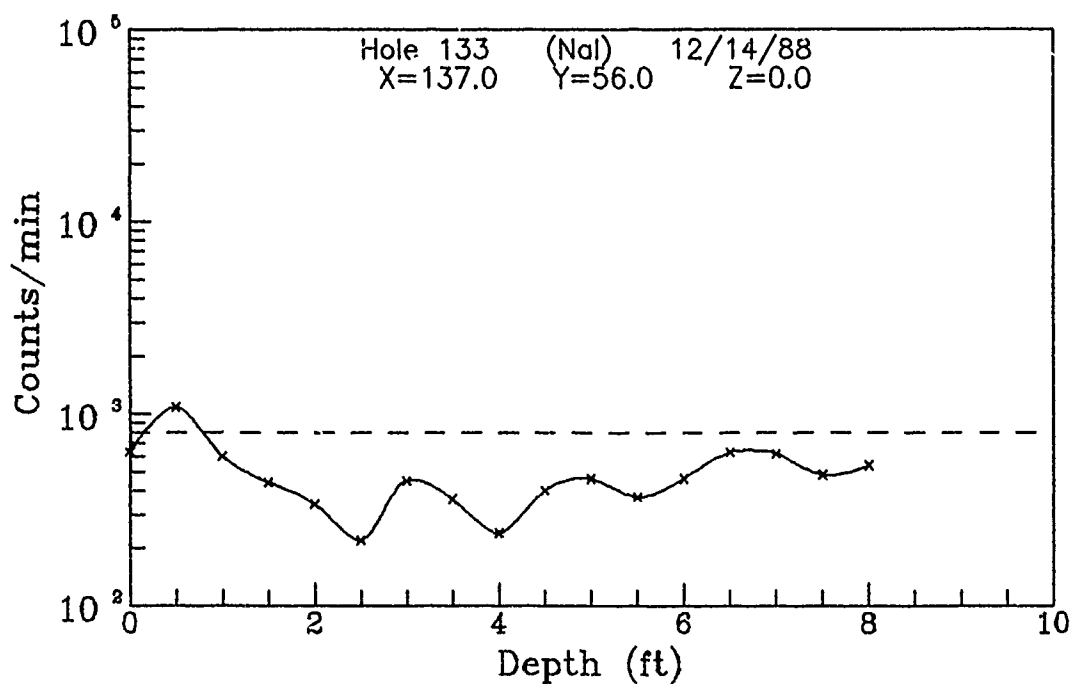


Figure C60. Subsurface Data from 107 E. Stratford in
Map Region 49

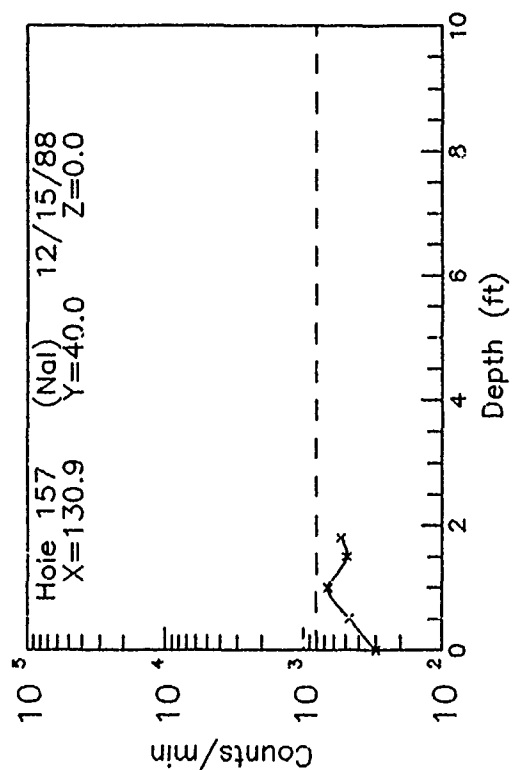
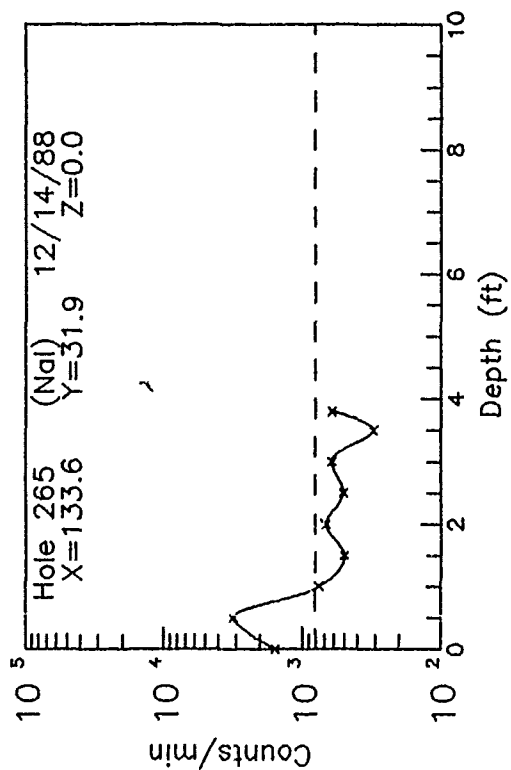
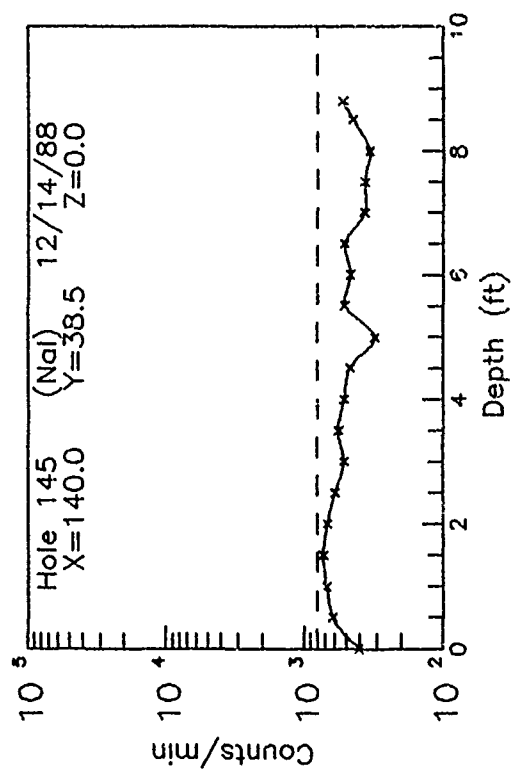
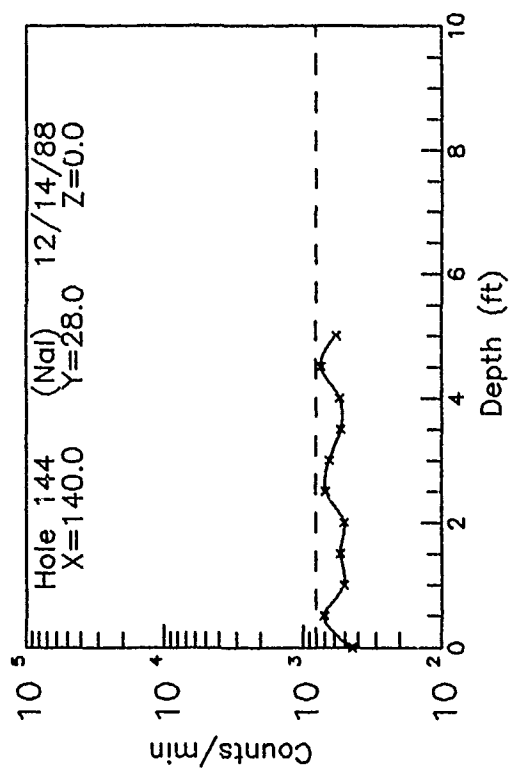


Figure C61. Subsurface Data from 107 E. Stratford in Map Region 50

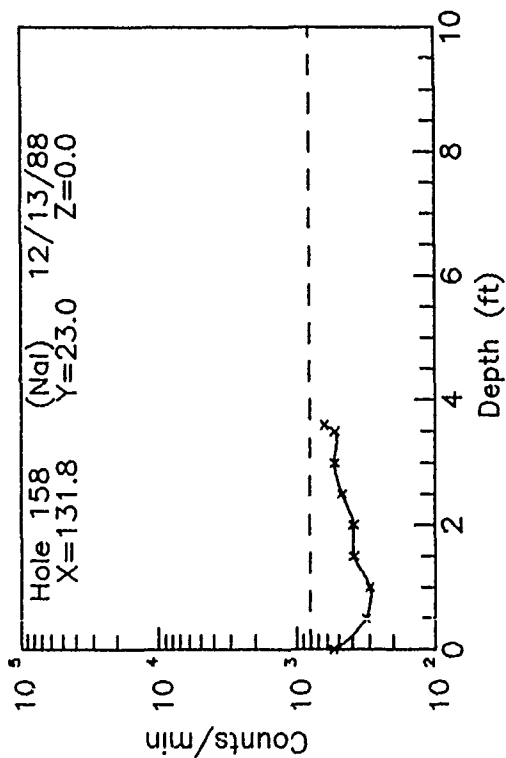
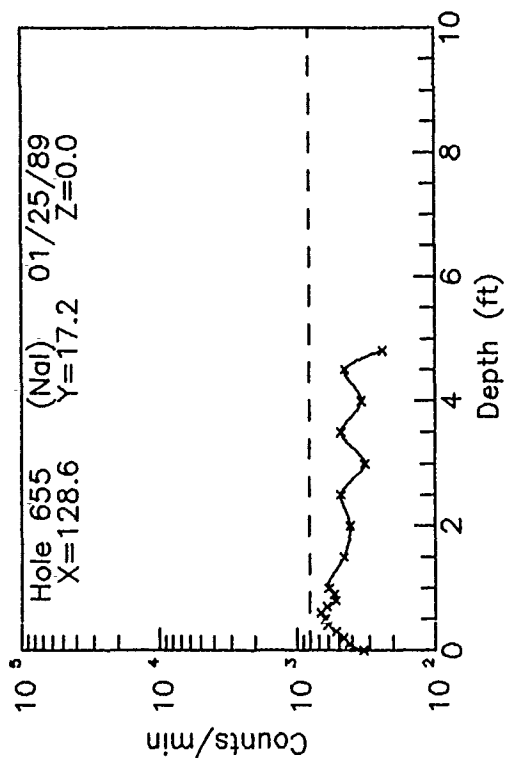
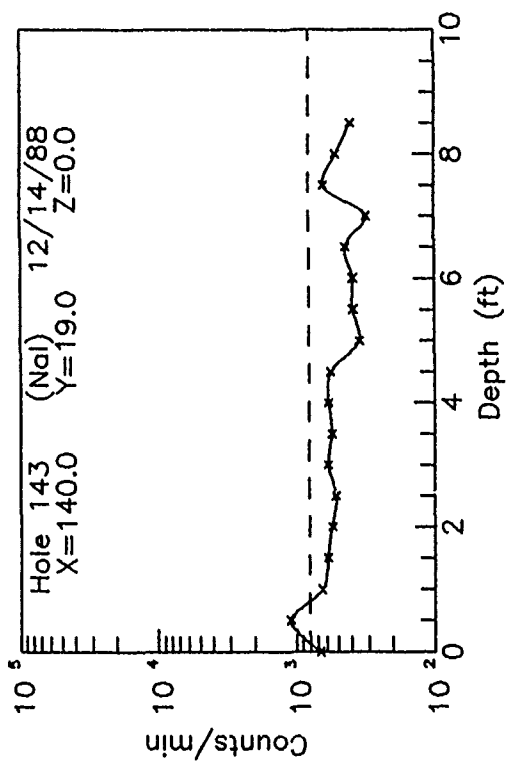
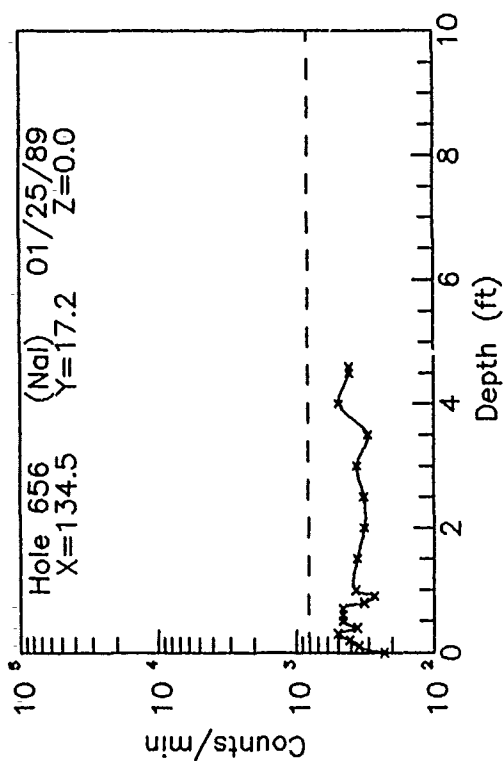


Figure C62. Subsurface Data from 107 E. Stratford in Map Region 51

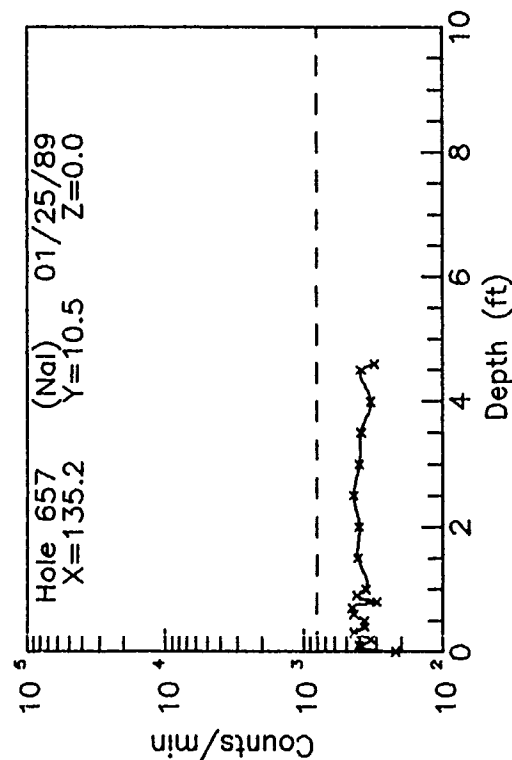
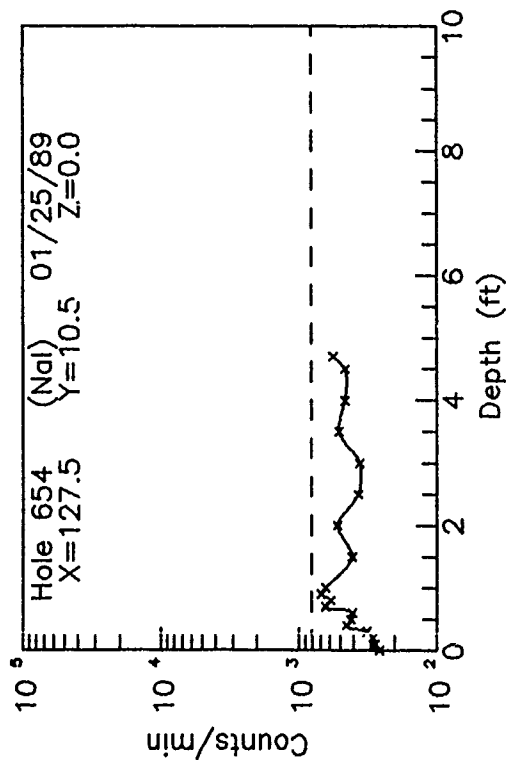
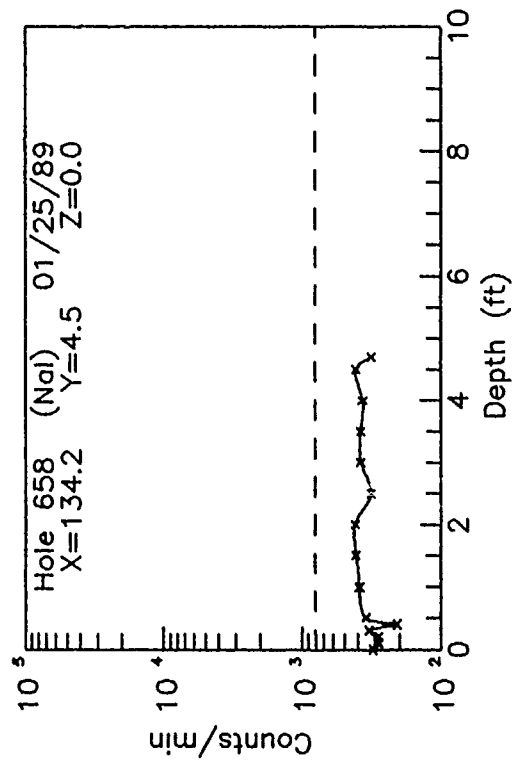
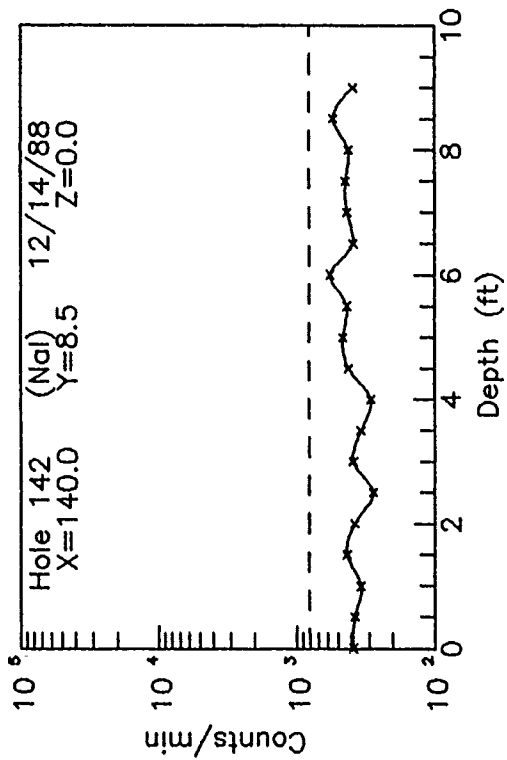


Figure C63. Subsurface Data from 107 E. Stratford Garage in Map Region 52

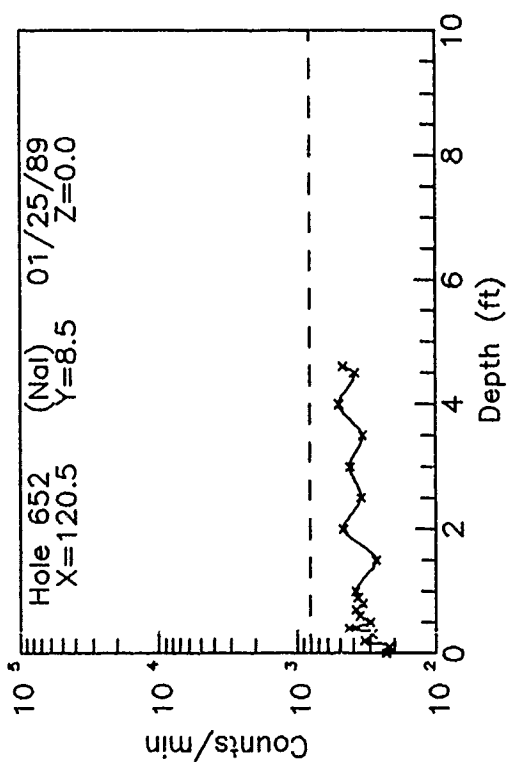
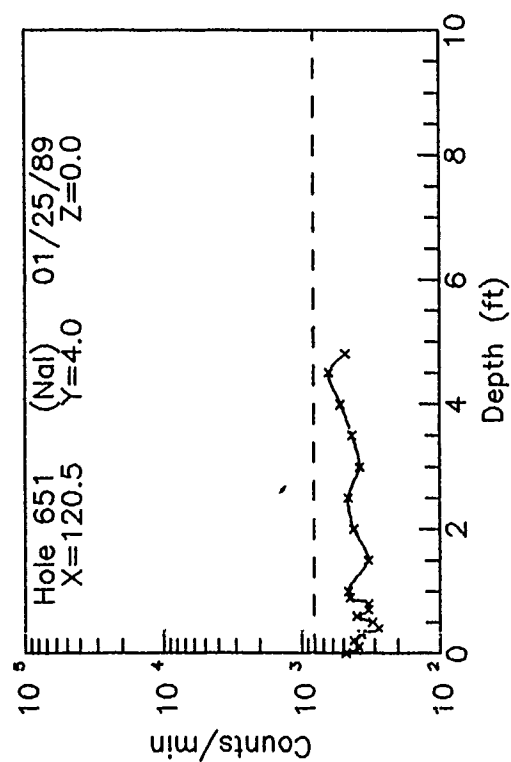
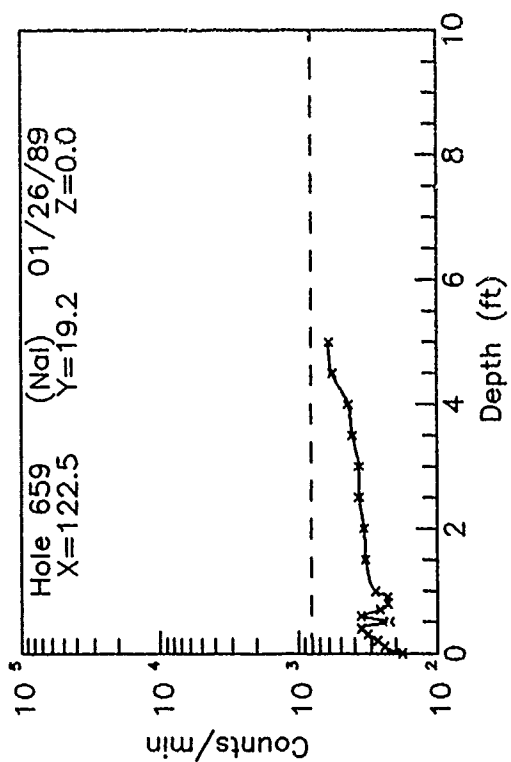
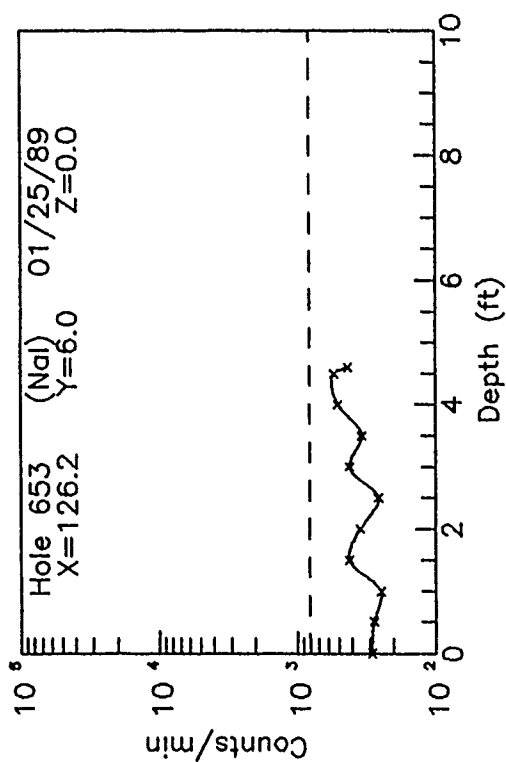


Figure C64. Subsurface Data from 107 E. Stratford in Map Region 53

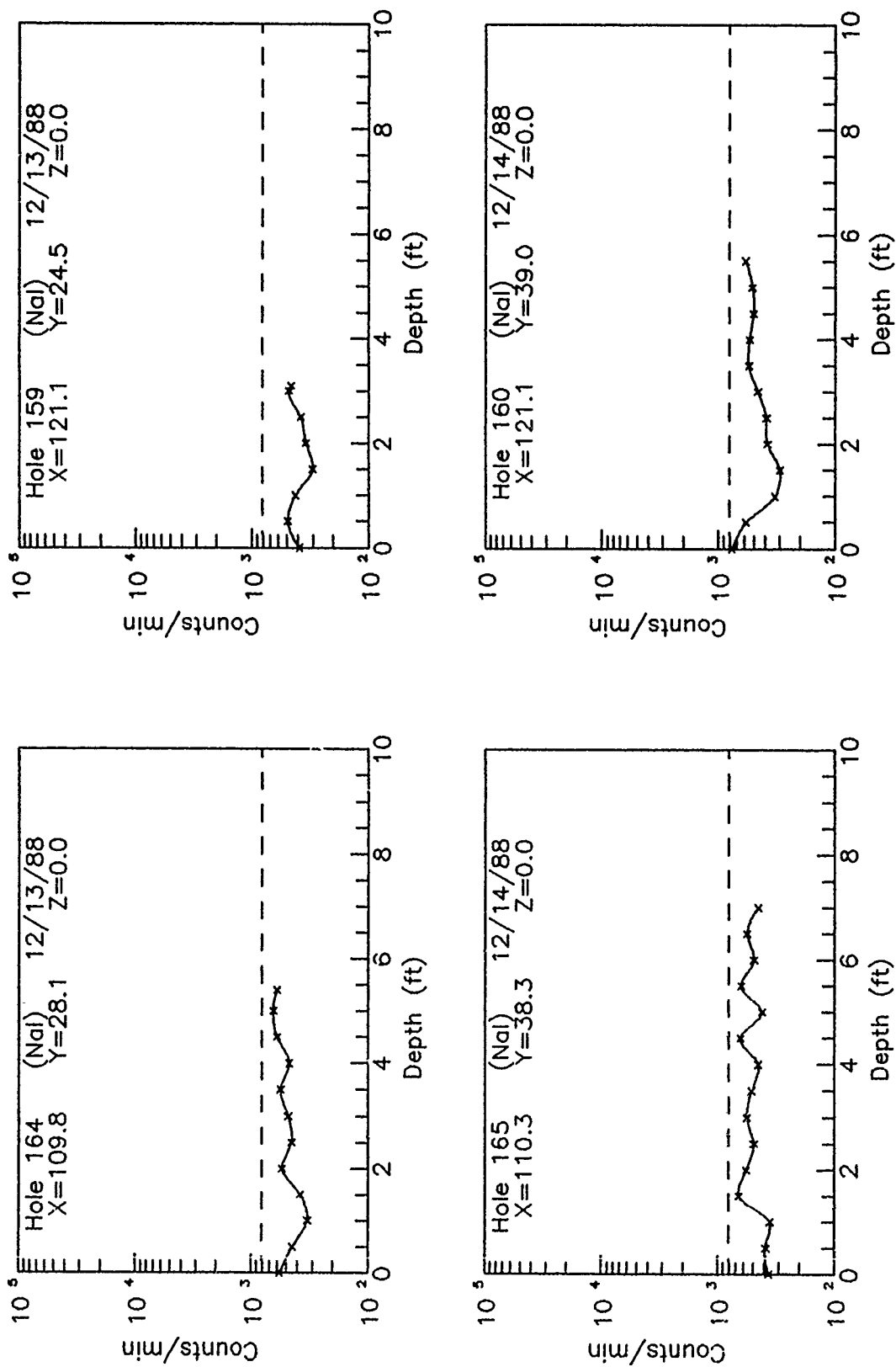


Figure C65. Subsurface Data from 107 E. Stratford in Map Region 54

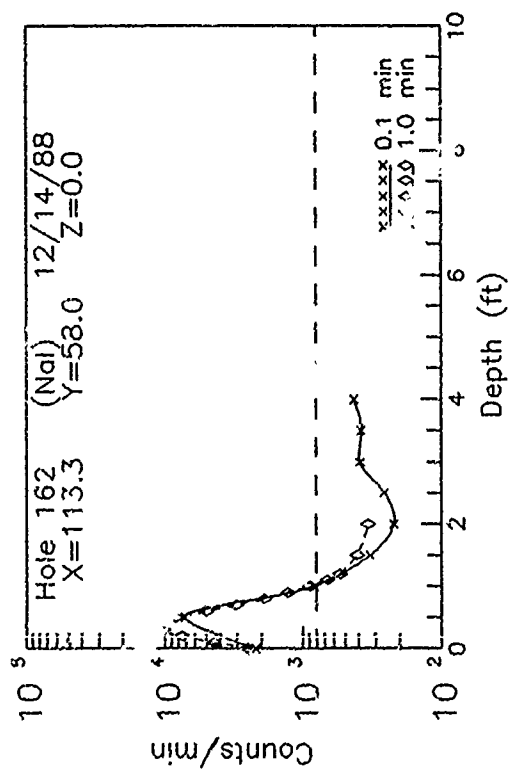
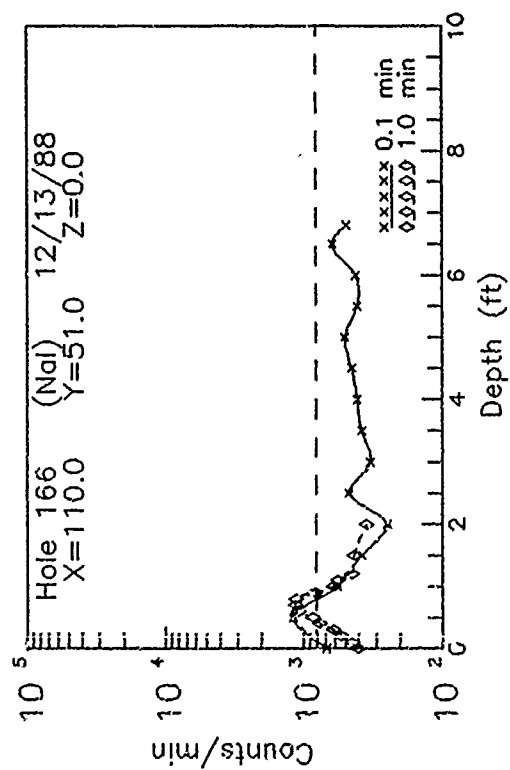
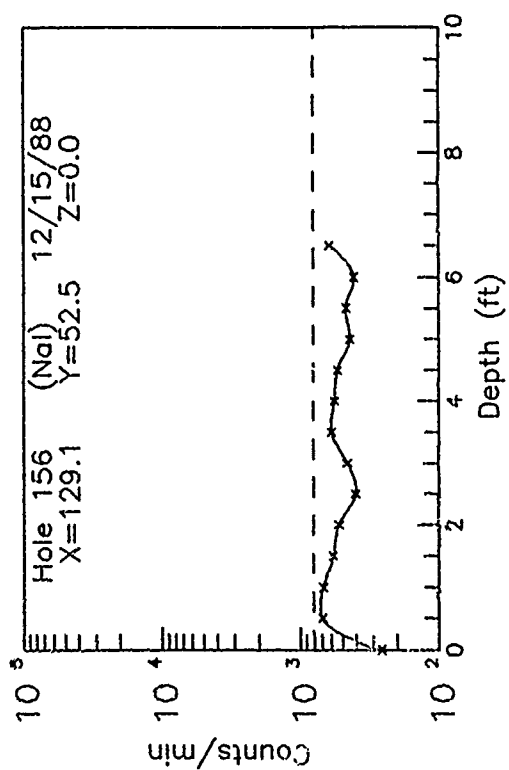
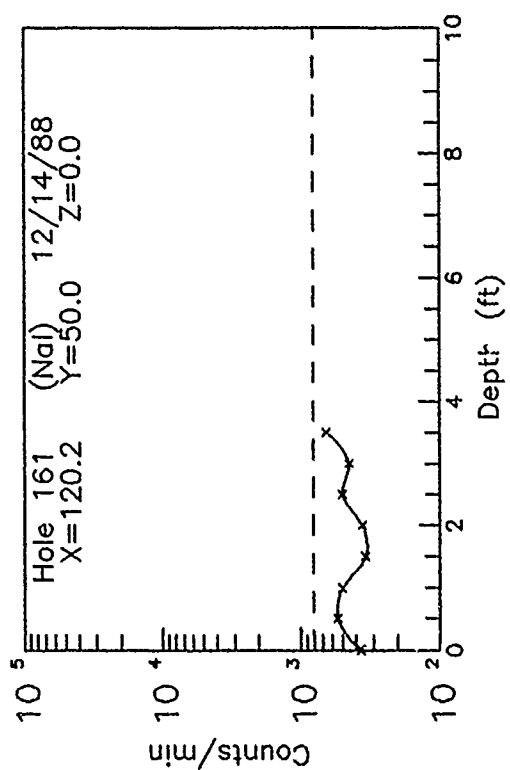


Figure C66. Subsurface Data from 107 E. - Hatford in Map Region 55

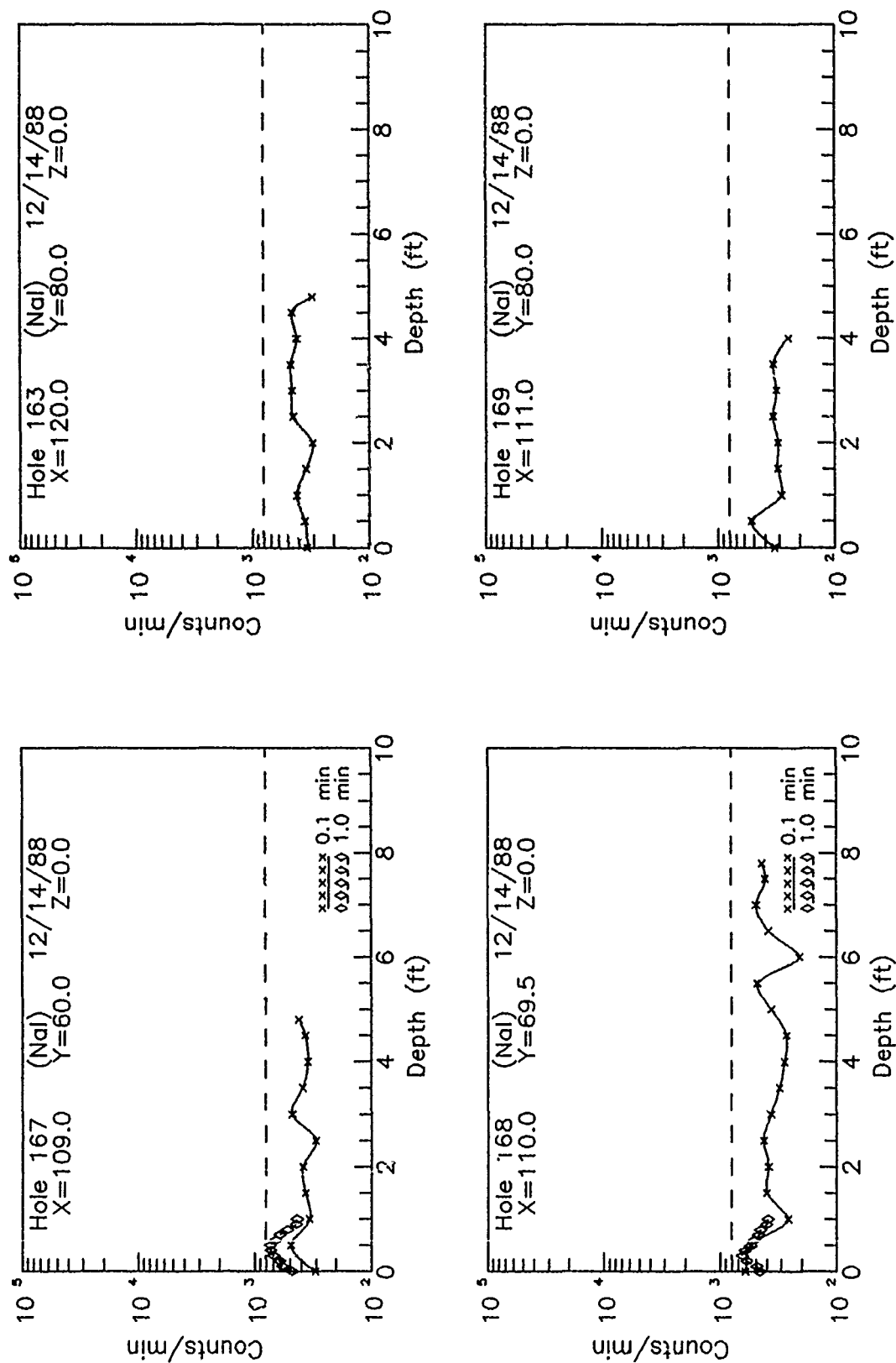


Figure C67. Subsurface Data from 107 E. Stratford in Map Region 56

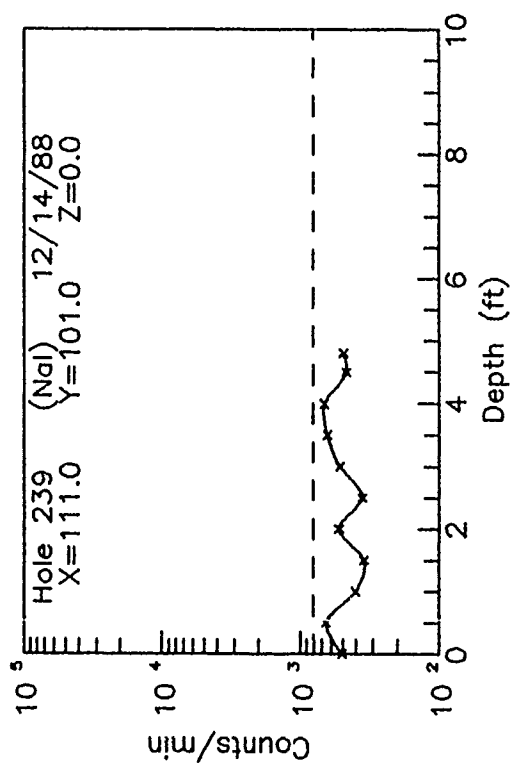
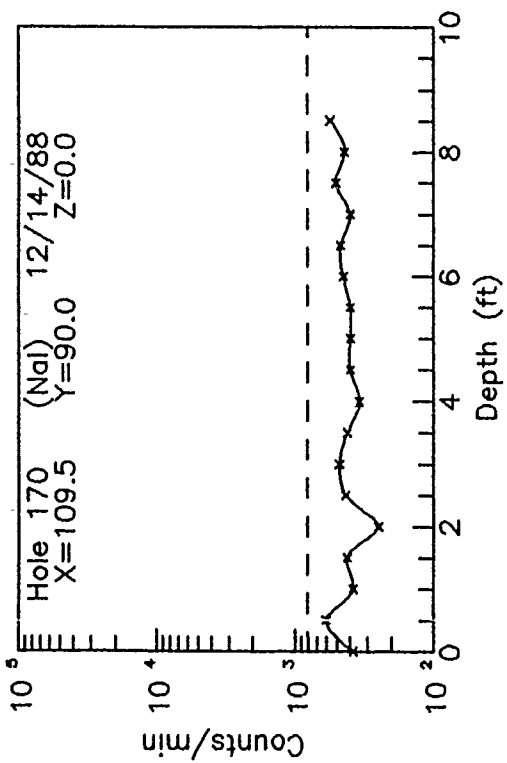
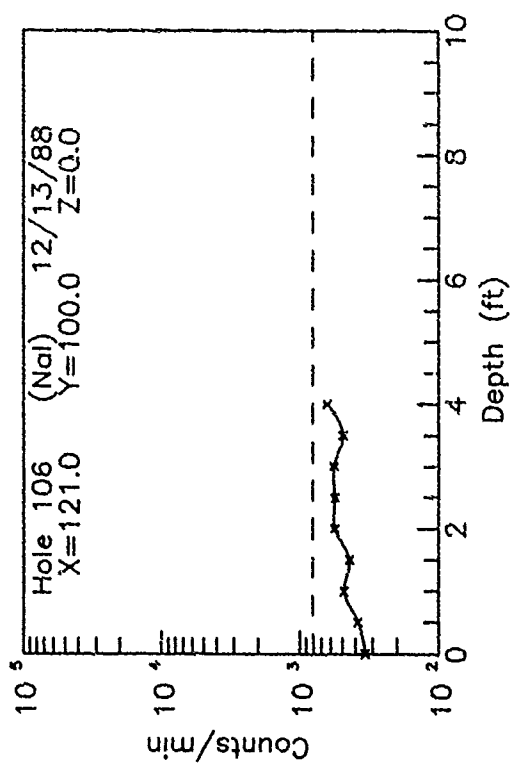
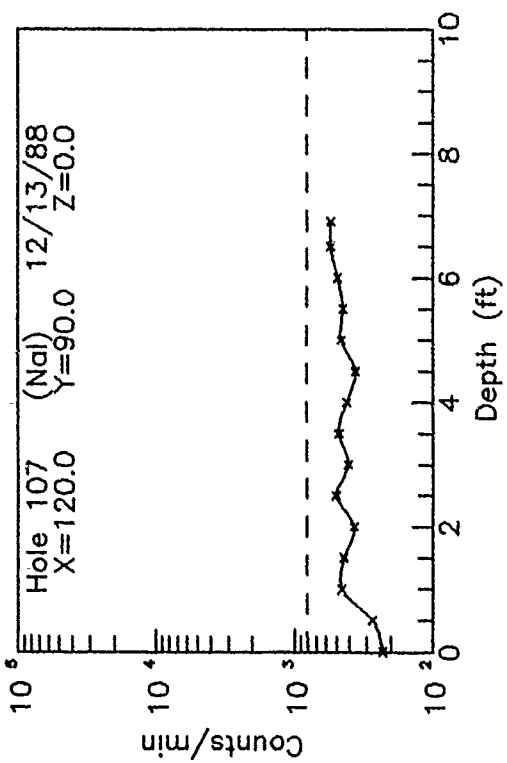


Figure C68. Subsurface Data from 107 E. Stratford in Map Region 57

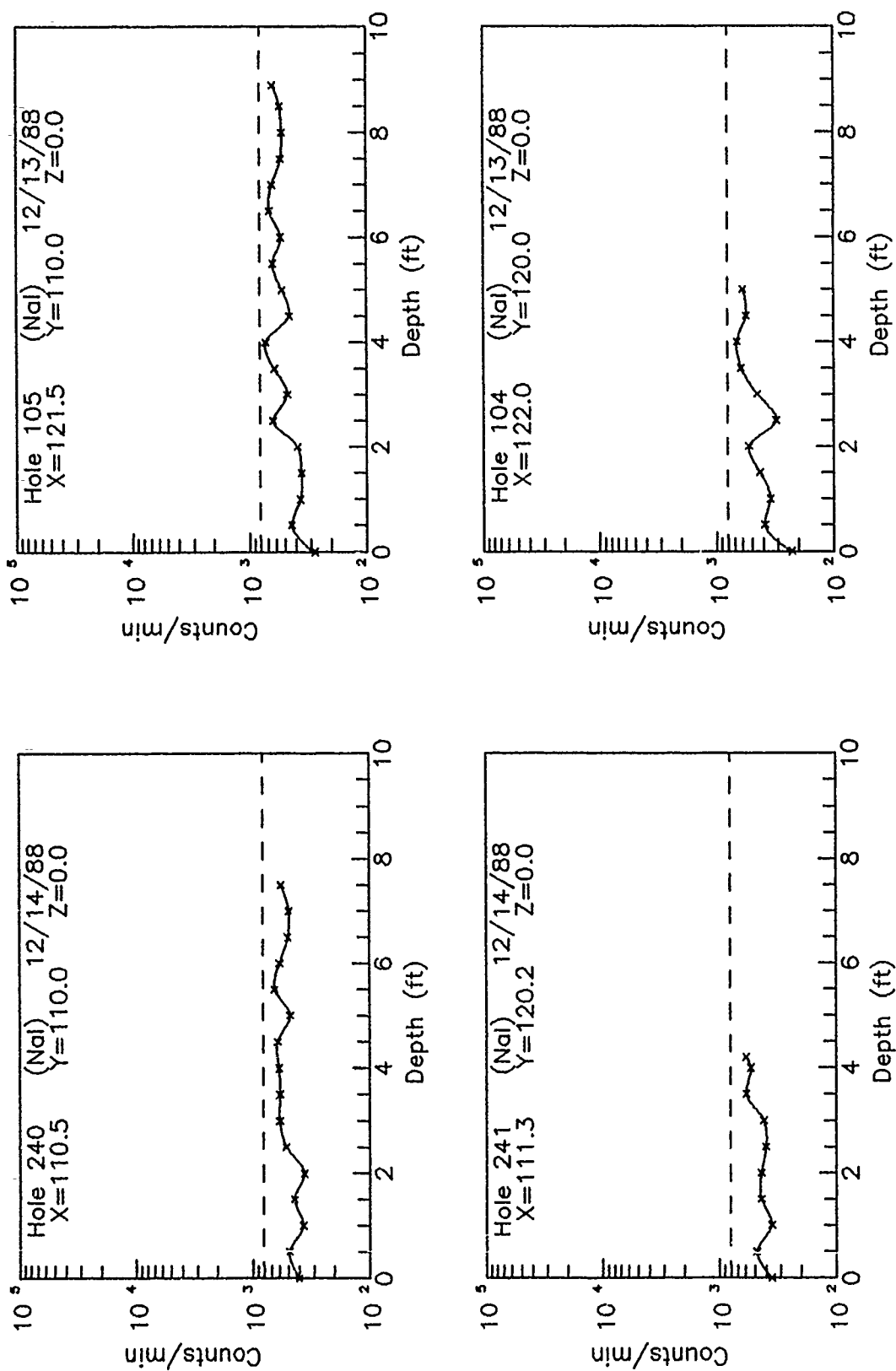


Figure C69. Subsurface Data from 107 E. Stratford in Map Region 58

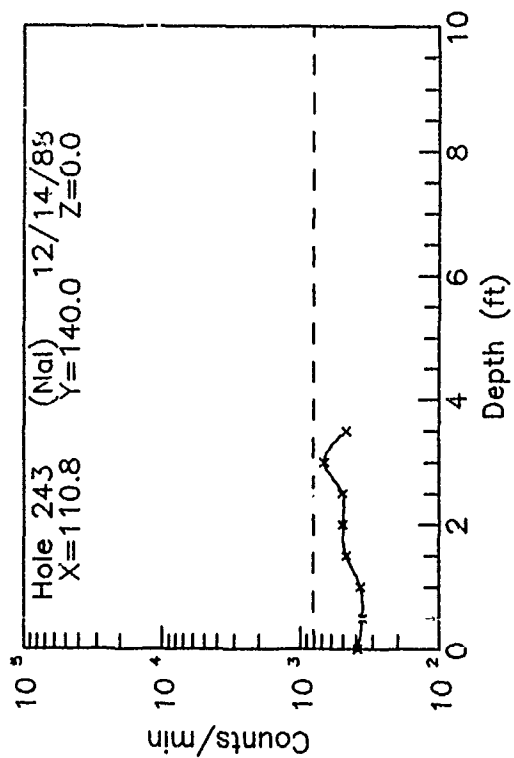
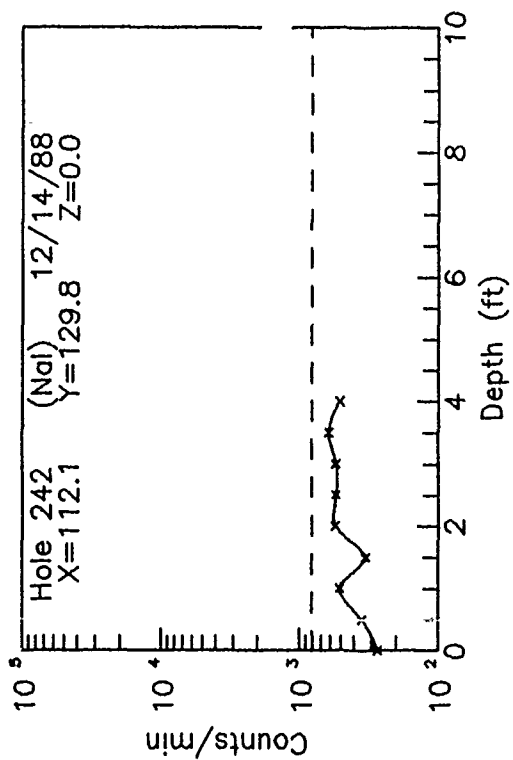
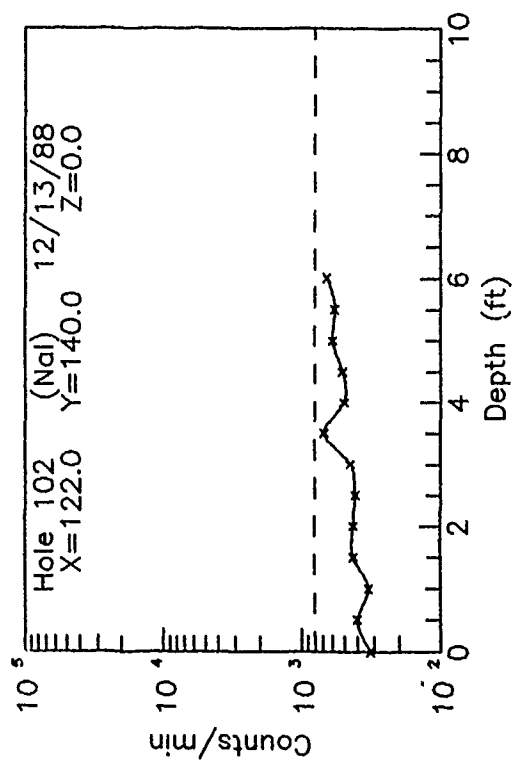
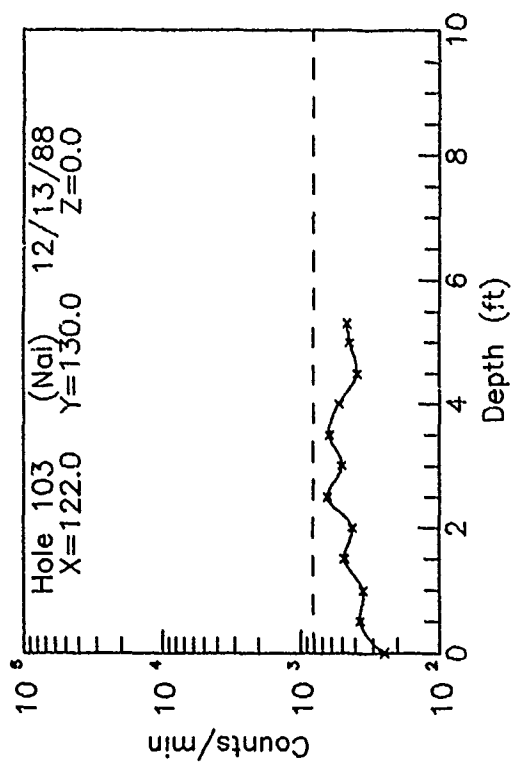


Figure C70. Subsurface Data from 107 E. Stratford in Map Region 59

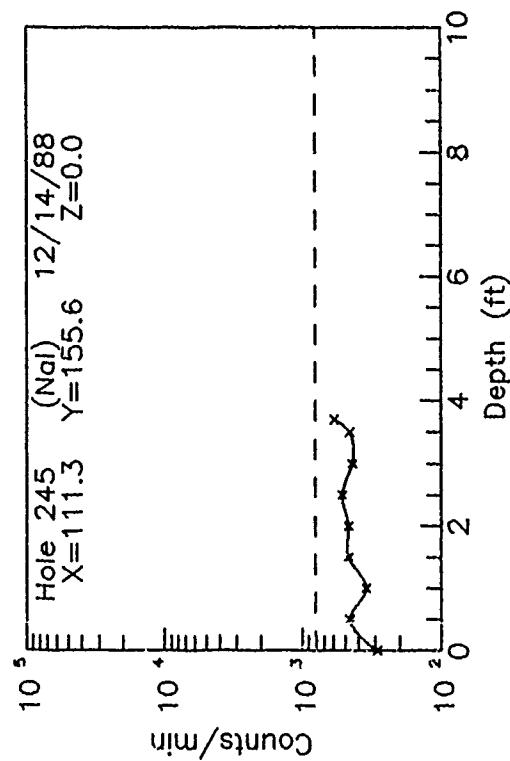
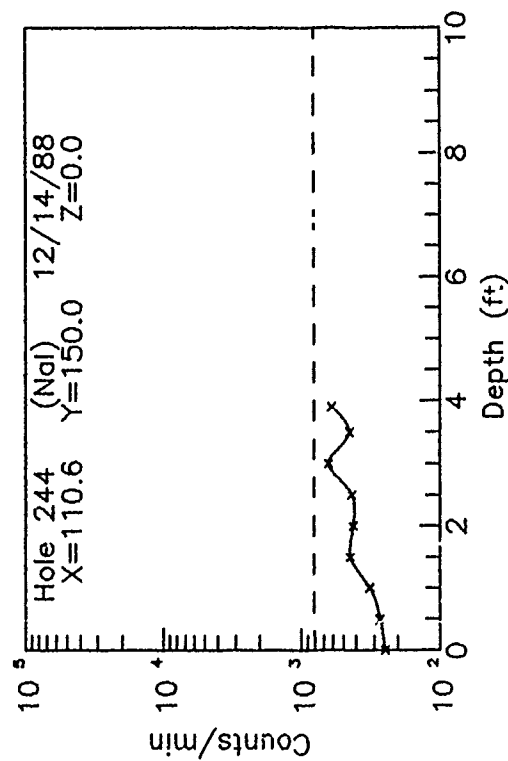
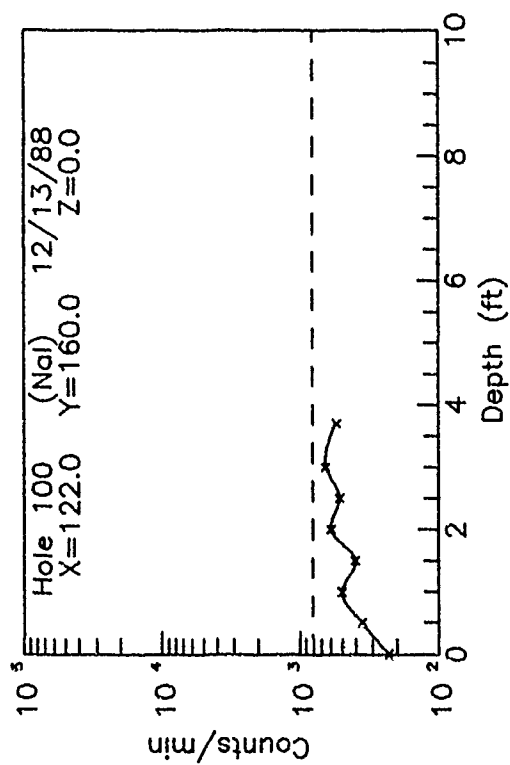
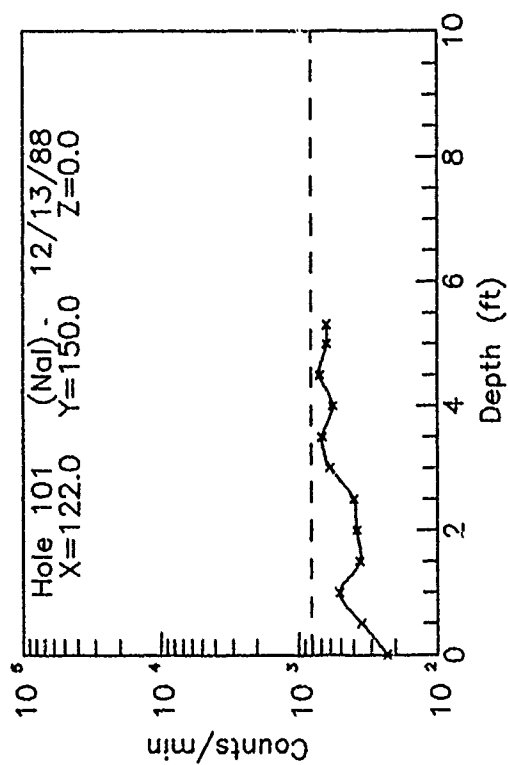


Figure C71. Subsurface Data from 107 E. Stratford in Map Region 60

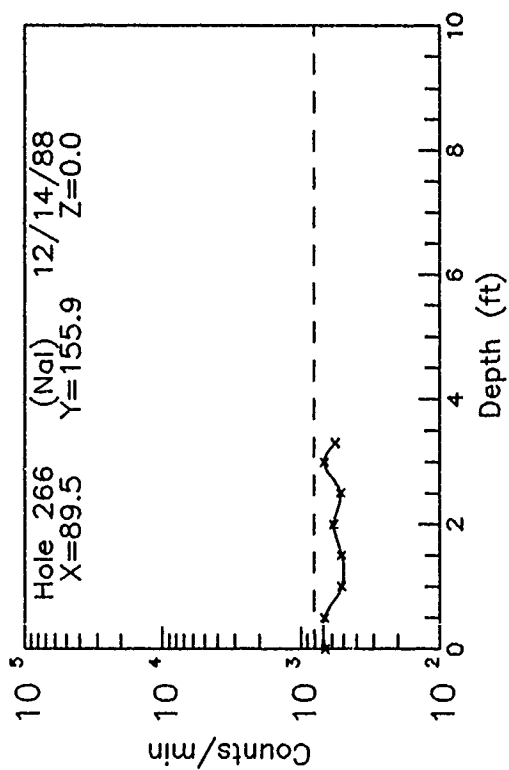
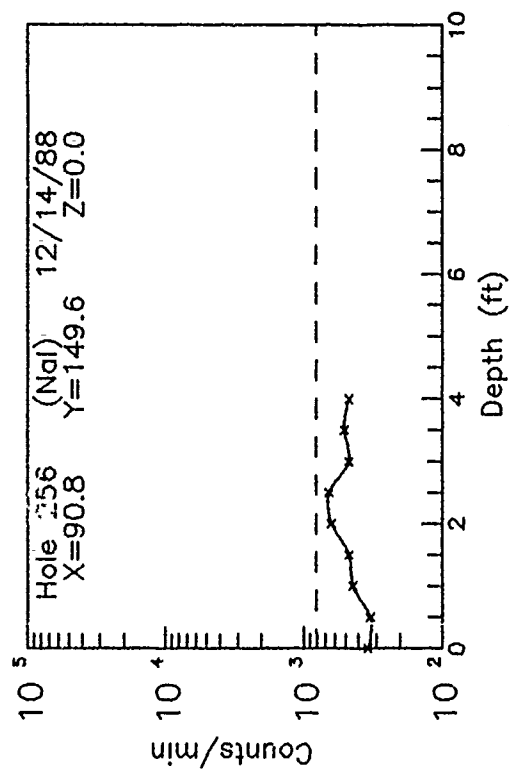
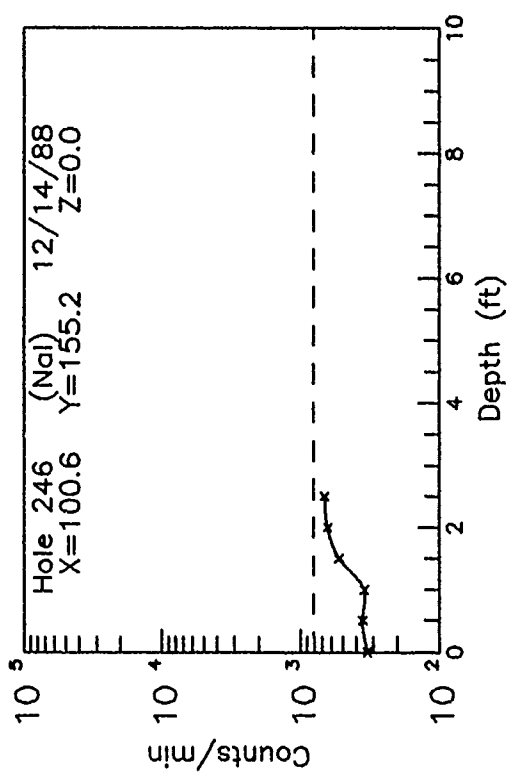
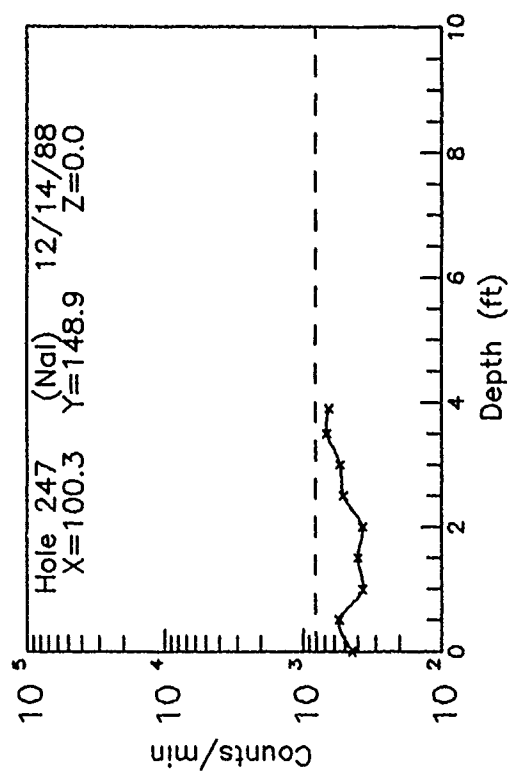


Figure C72. Subsurface Data from 107 E. Straford in Map Region 61

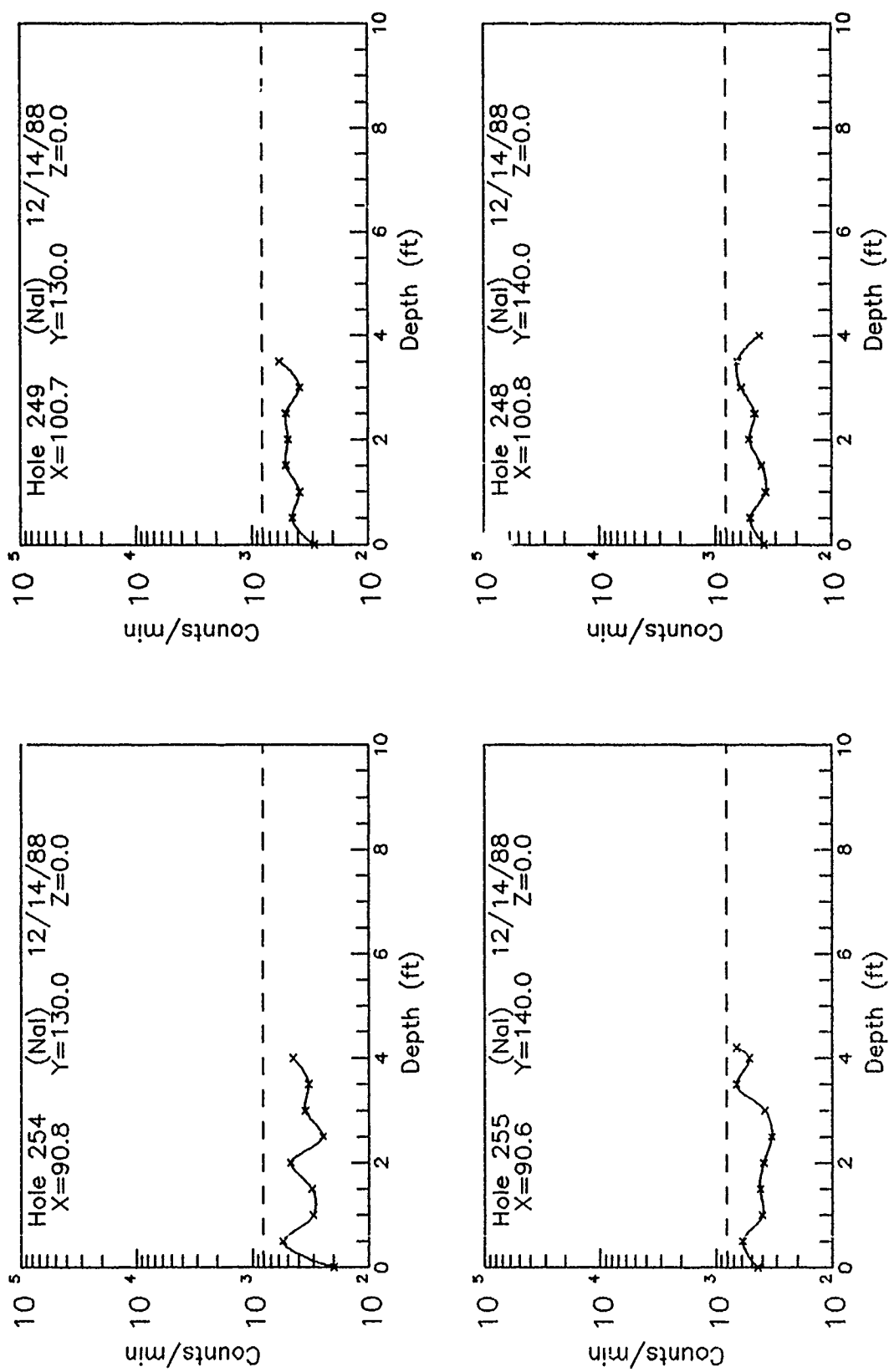


Figure C73. Subsurface Data from 107 E. Stratford in Map Region 62

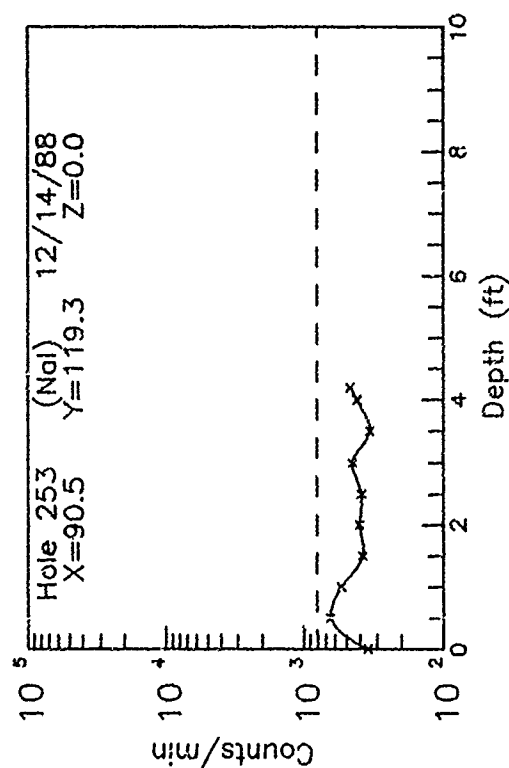
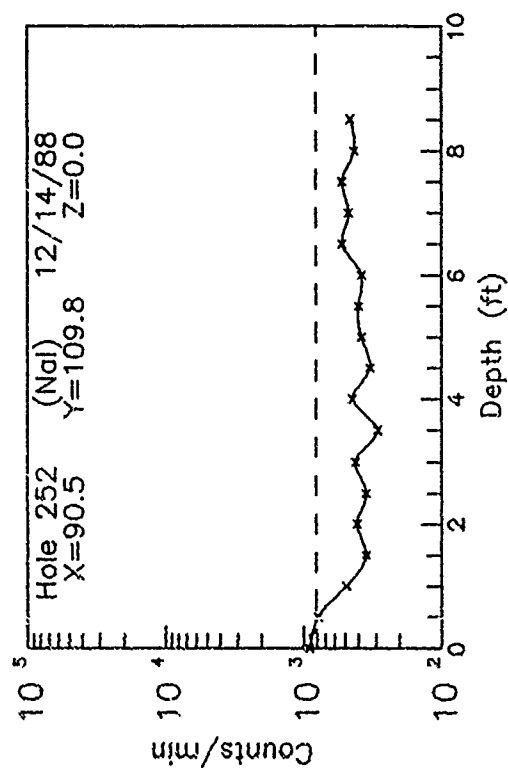
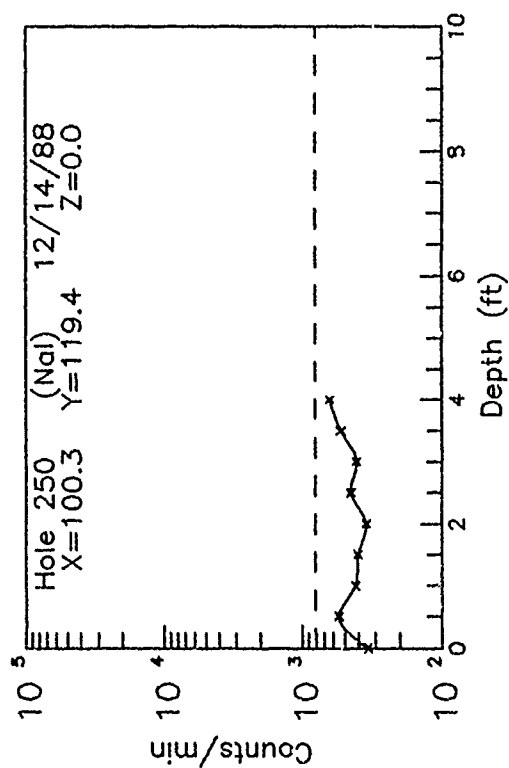
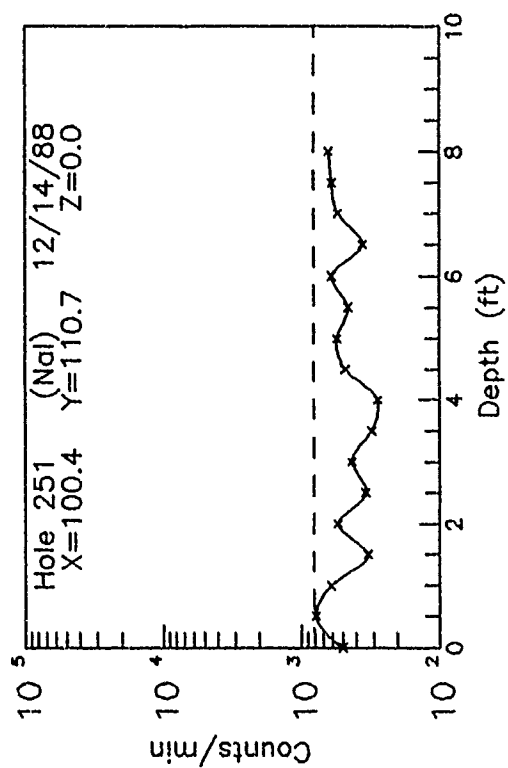


Figure C74. Subsurface Data from 107 E. Stratford in Map Region 63

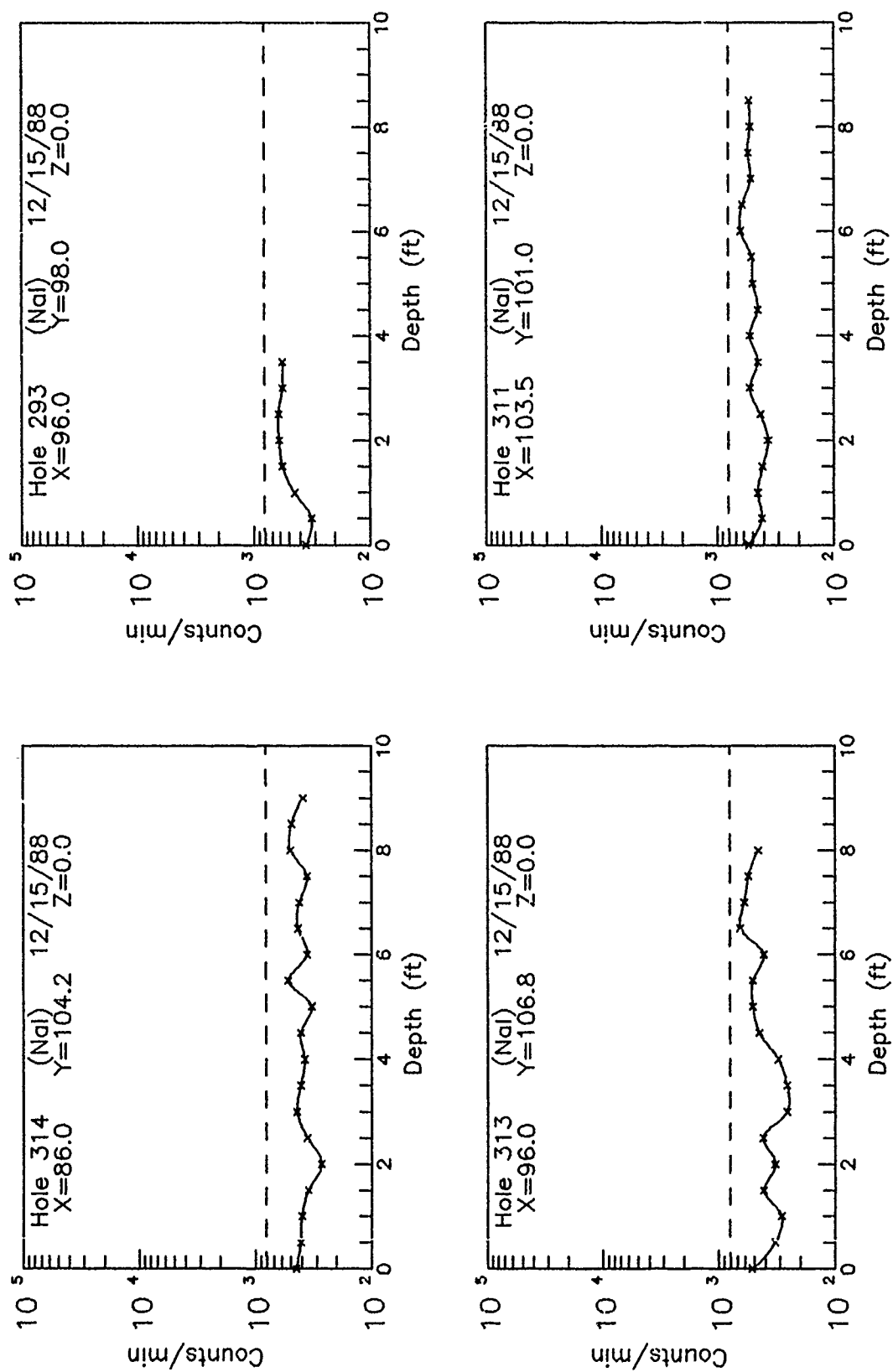


Figure C75. Subsurface Data from 107 E. Stratford in Map Region 64

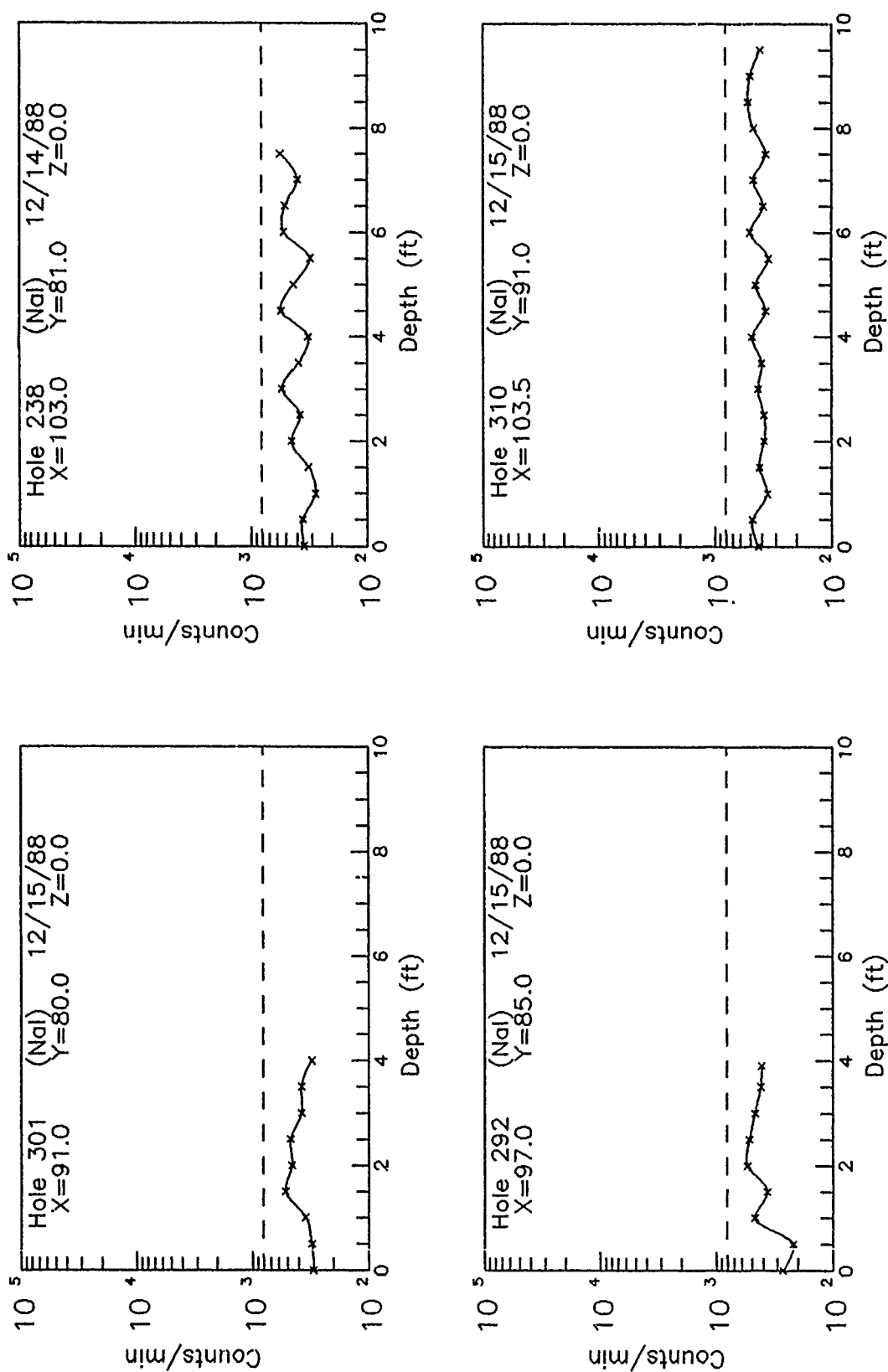


Figure C76. Subsurface Data from 107 E. Stratford in Map Region 65

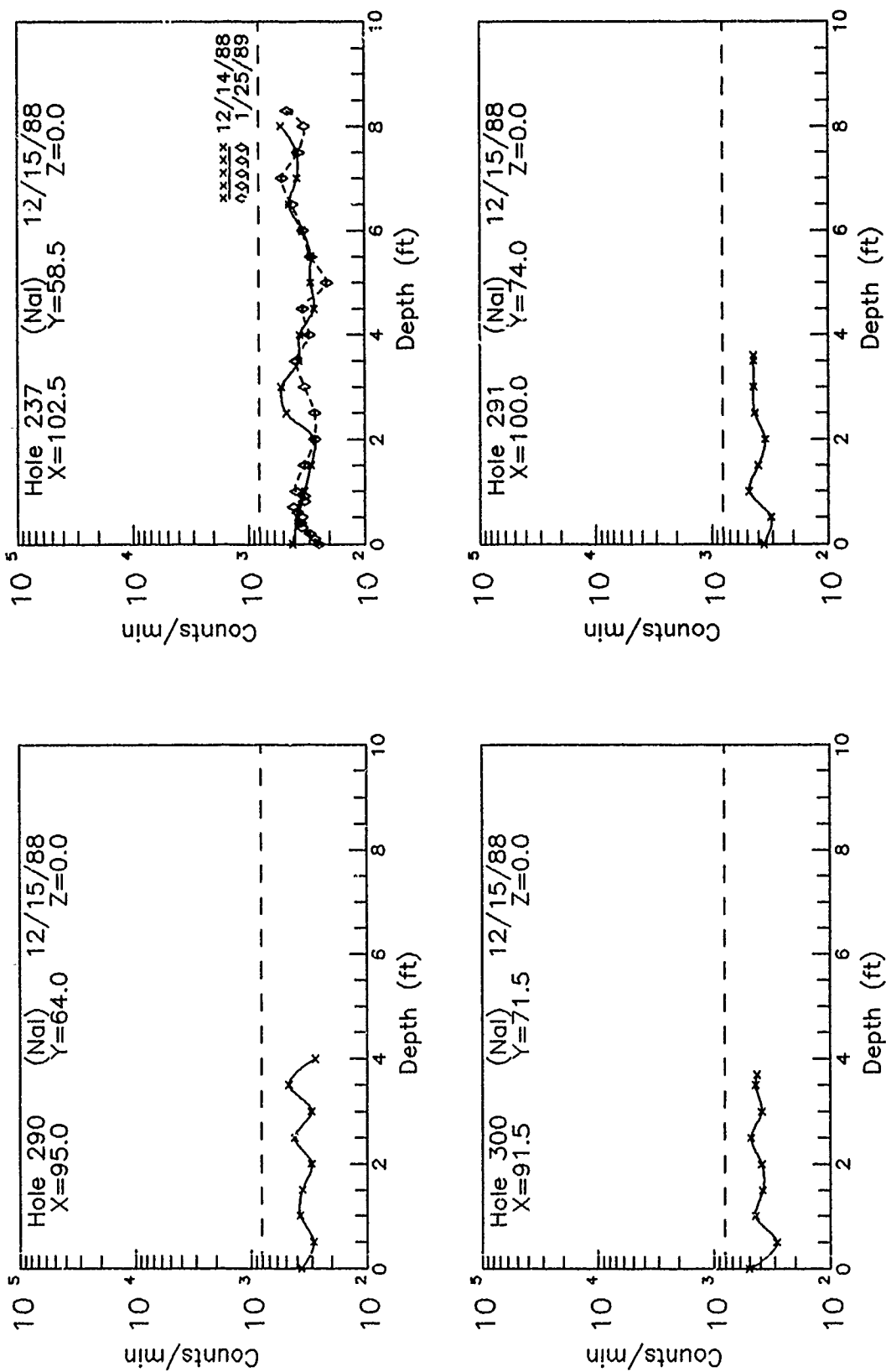


Figure C77. Subsurface Data from 107 E. Stratford in Map Region 66

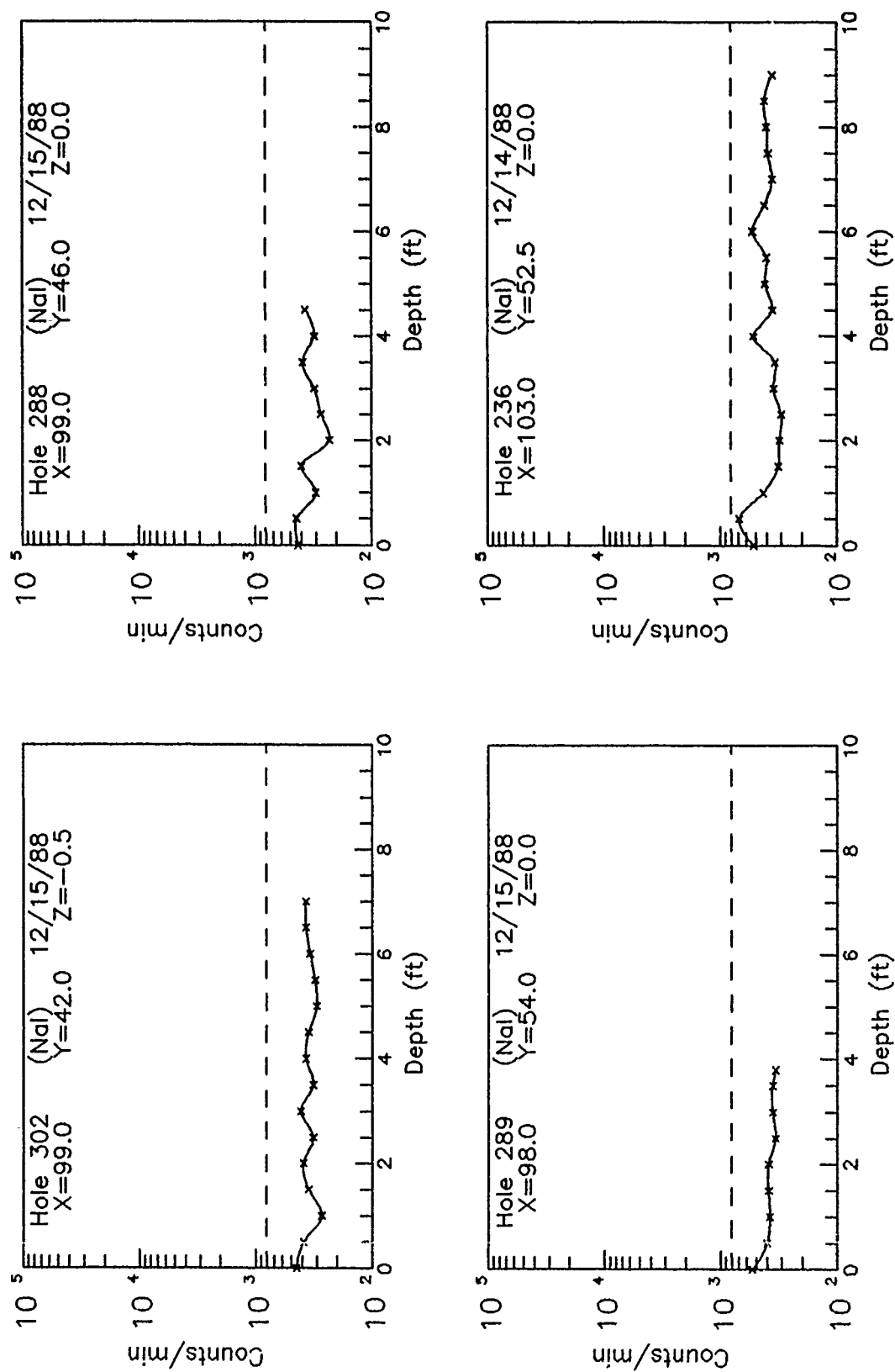


Figure C78. Subsurface Data from 107 E. Stratford in Map Region 67

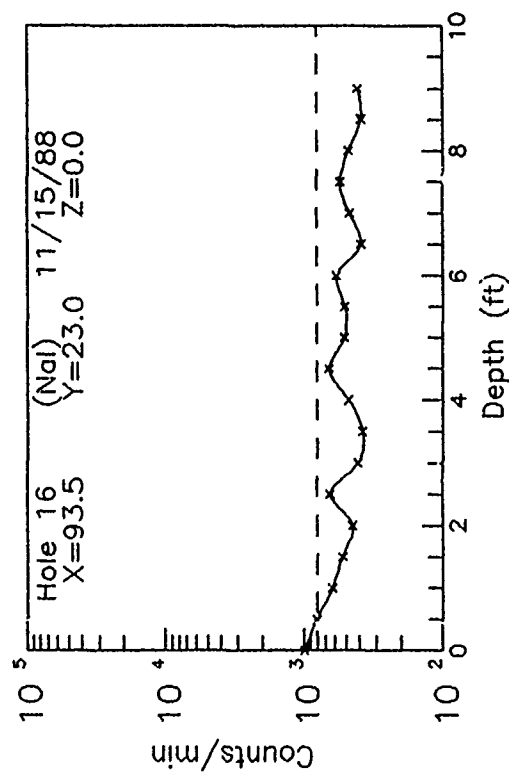
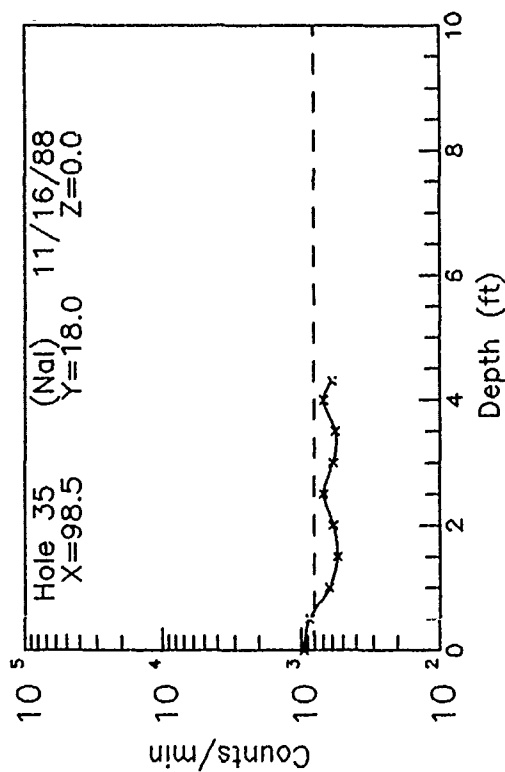
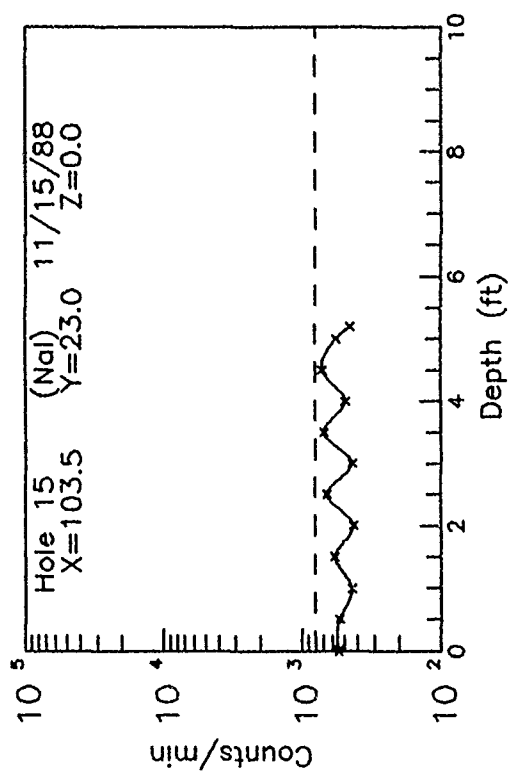
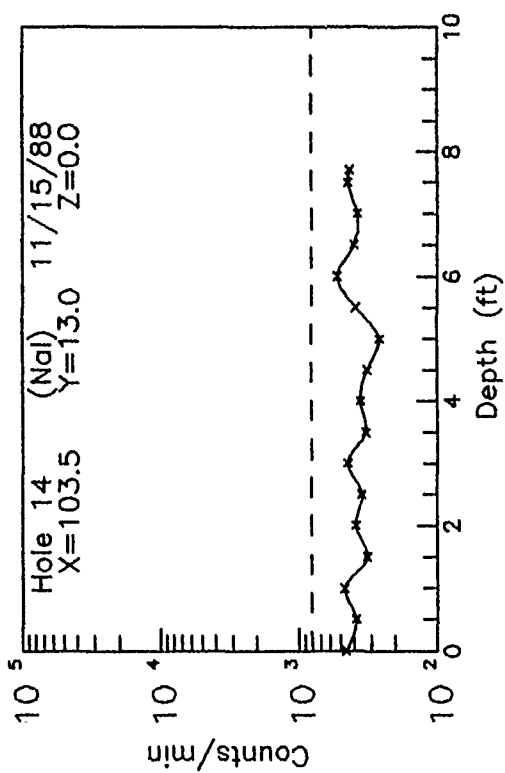


Figure C79. Subsurface Data from 107 E. Stratford in Map Region 68

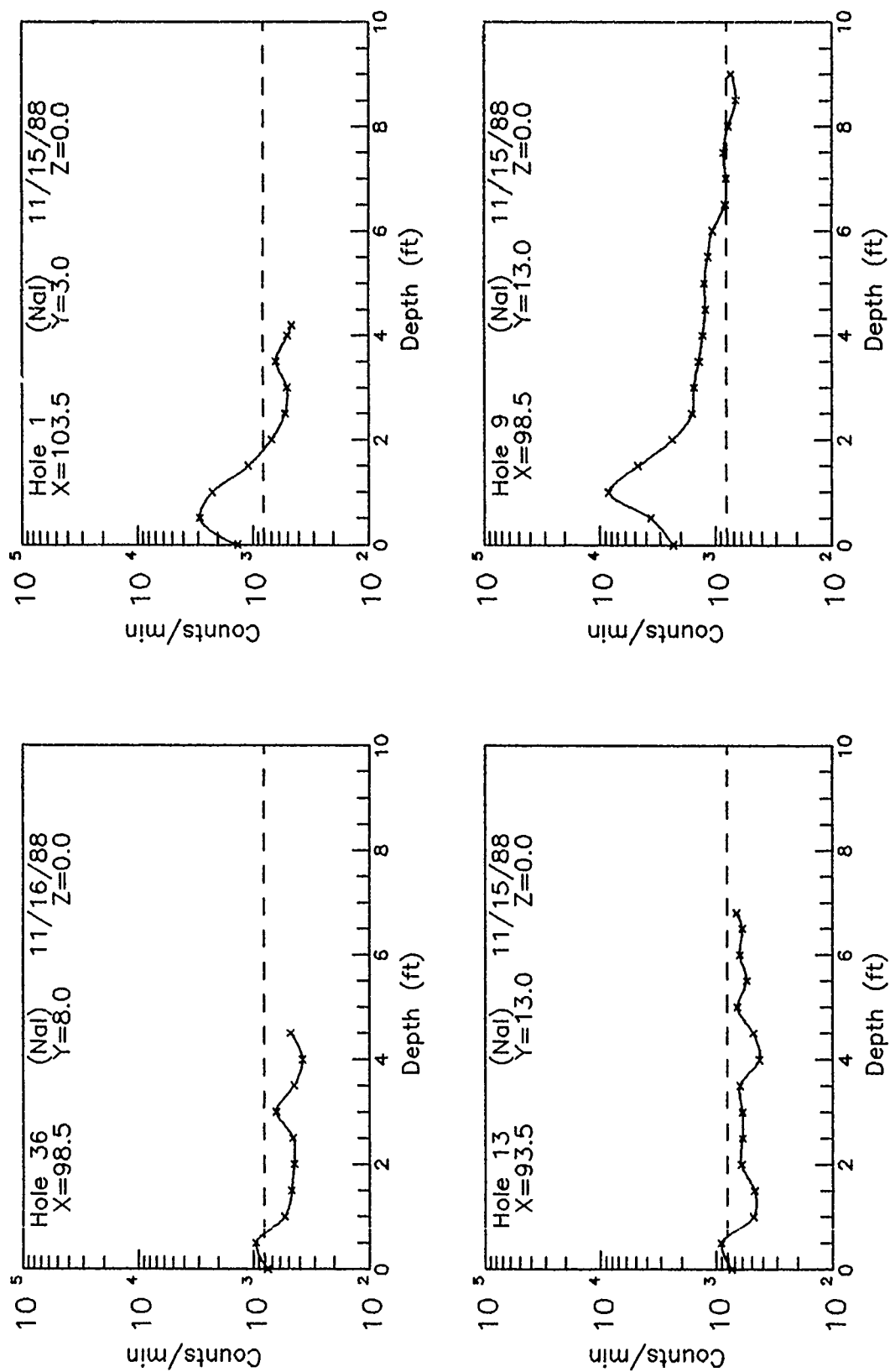


Figure C80. Subsurface Data from 107 E. Stratford in Map Region 69

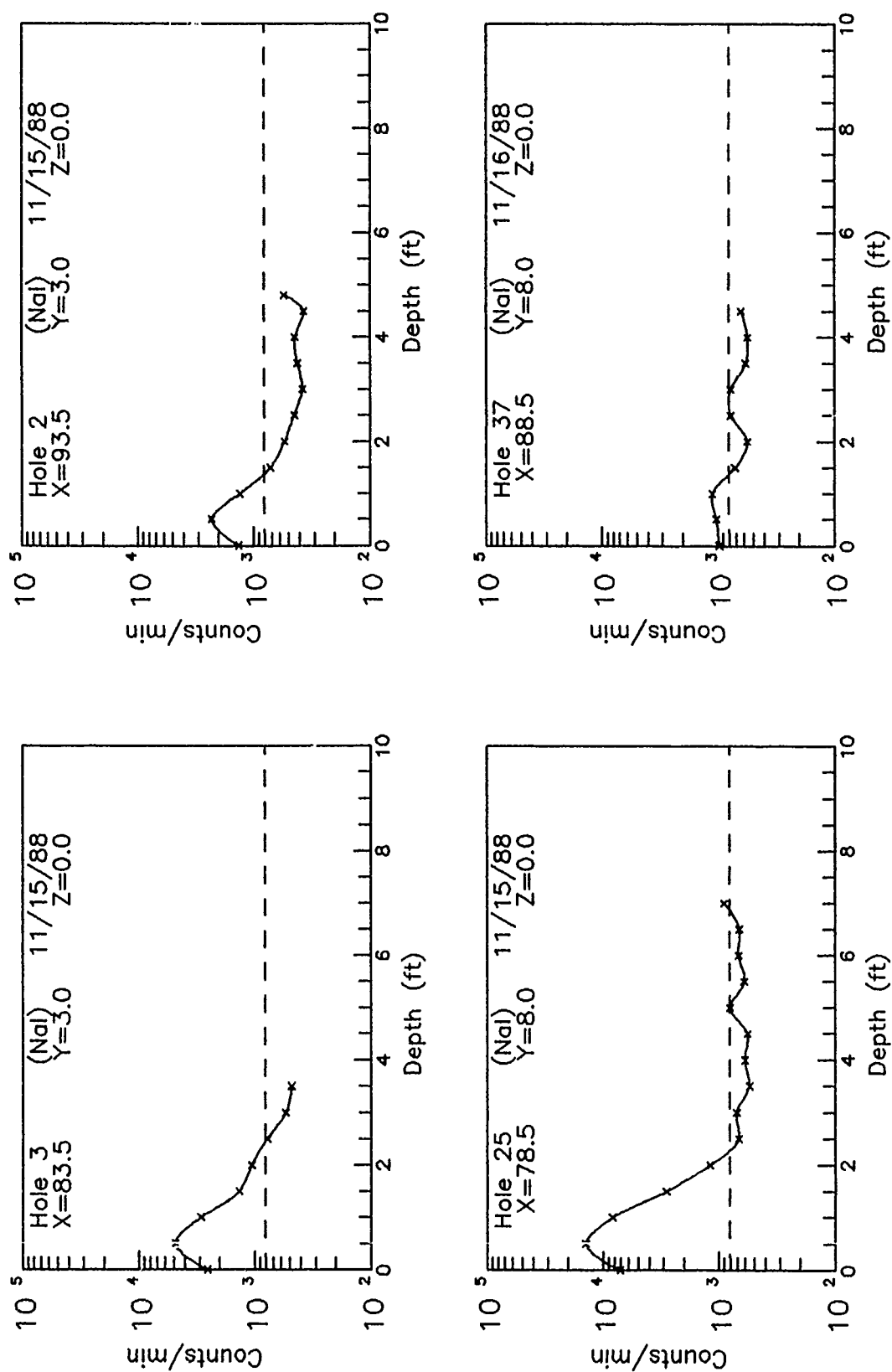


Figure C81. Subsurface Data from 105/107 E. Stratford in Map Region 70

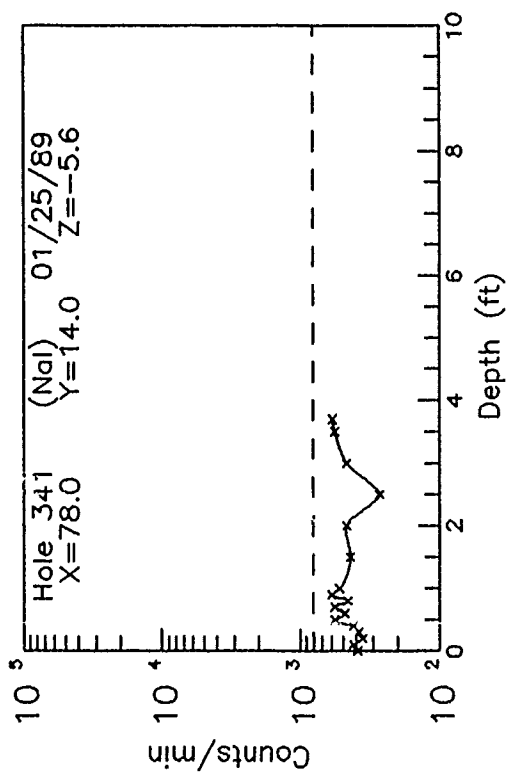
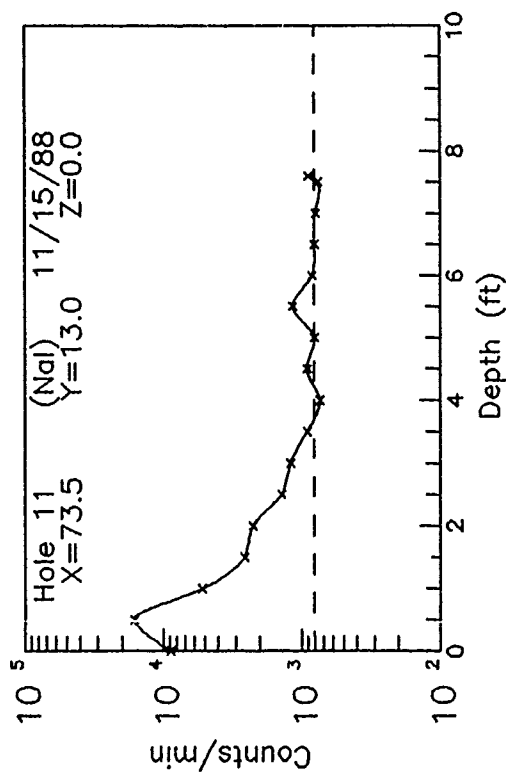
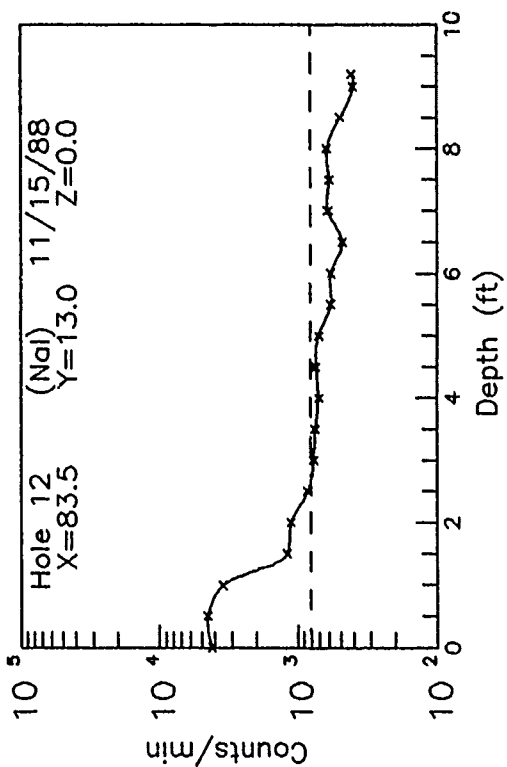
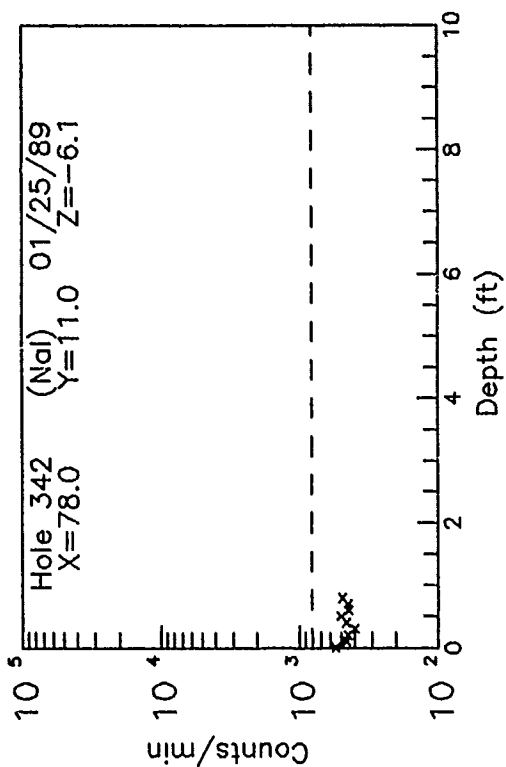


Figure C82. Subsurface Data from 105/107 E. Stratford in Map Region 71

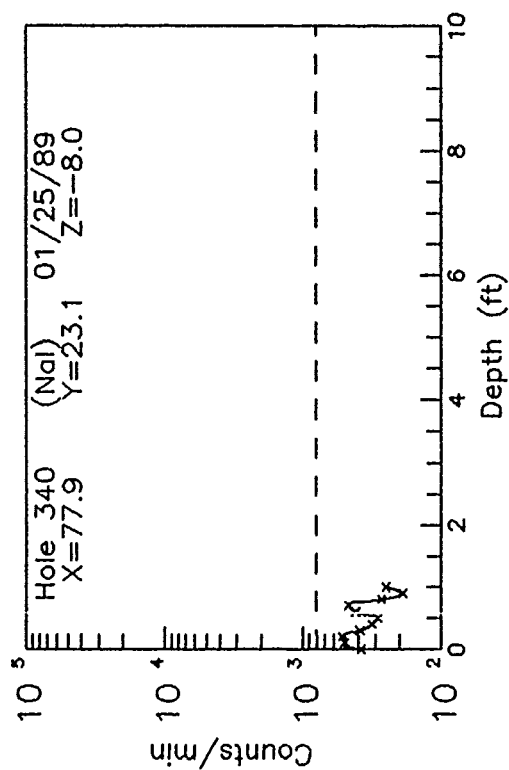
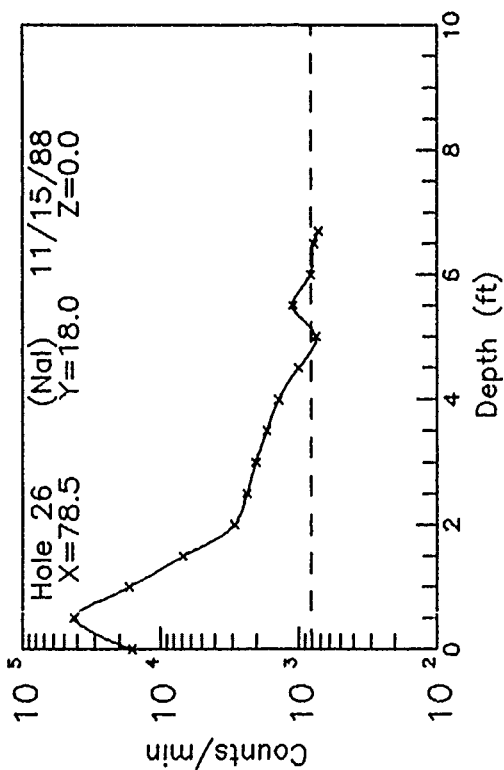
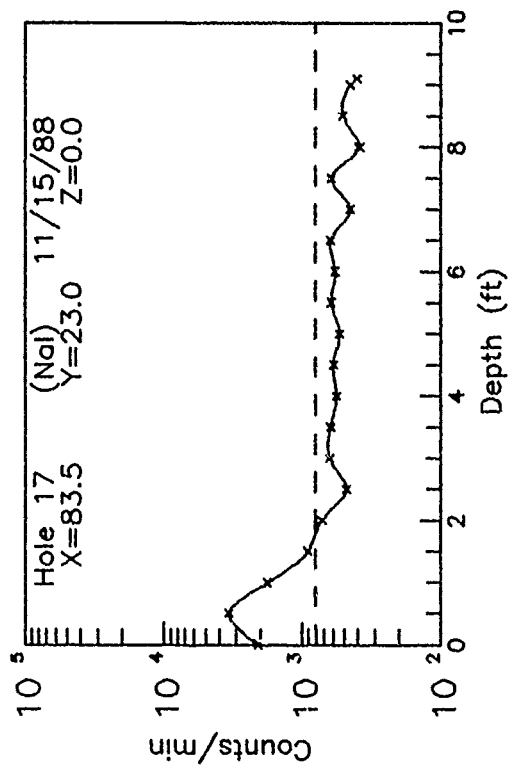
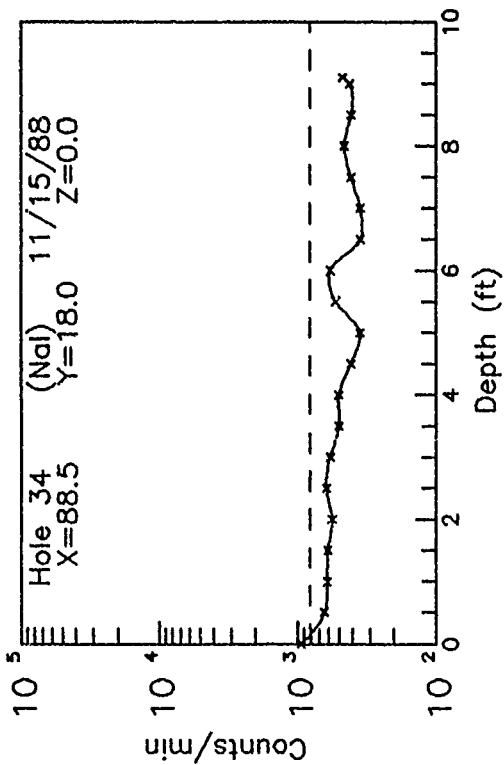


Figure C83. Subsurface Data from 105/107 E. Stratford in Map Region 72

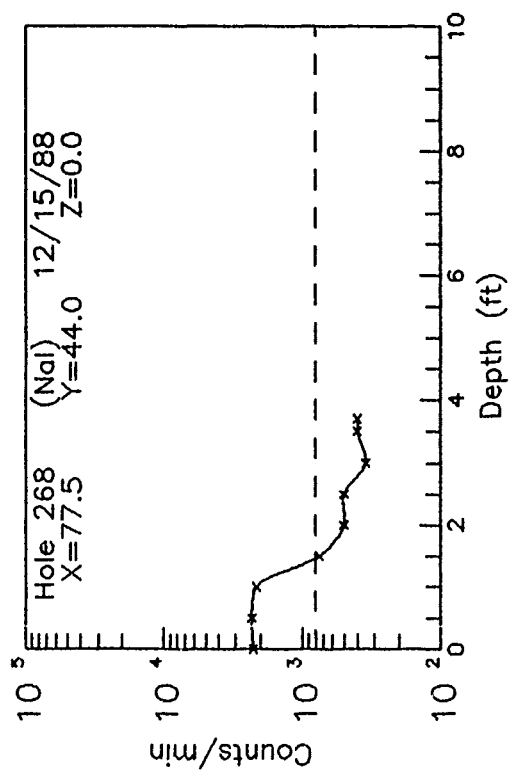
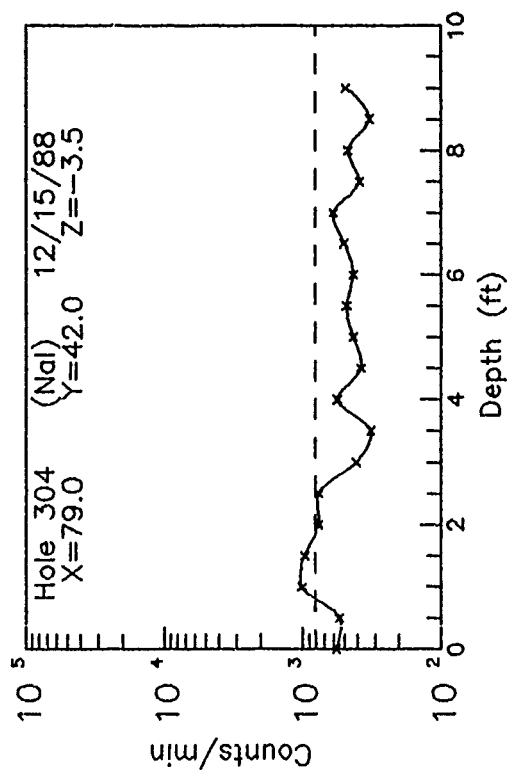
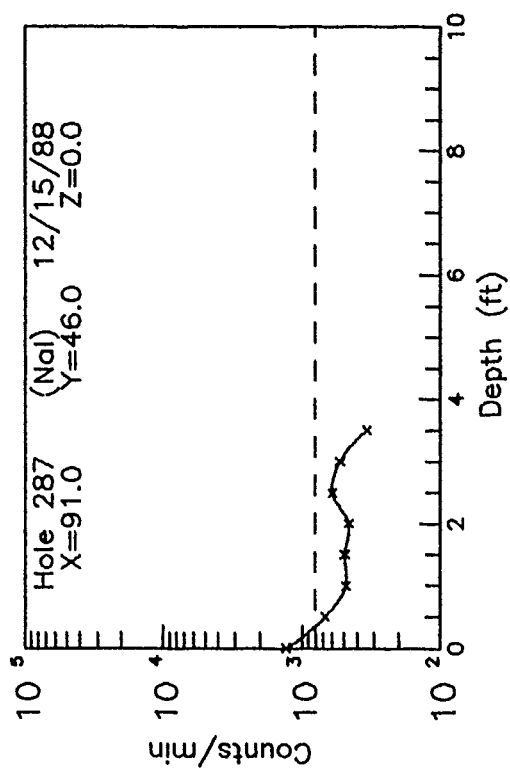
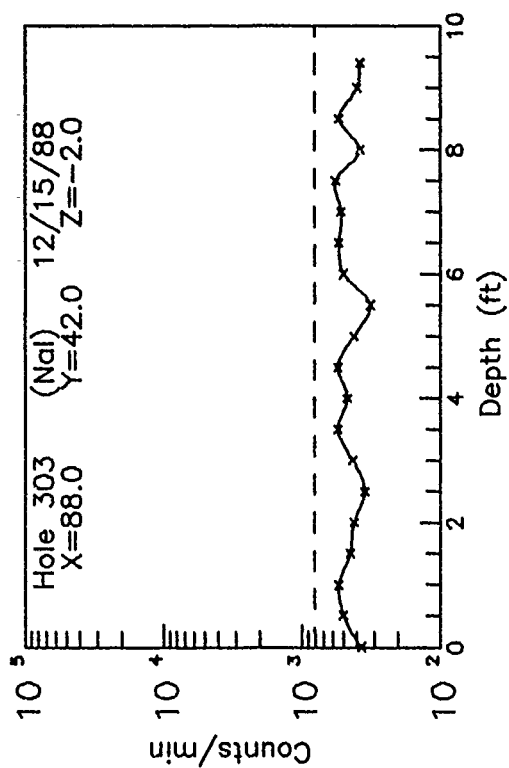


Figure C84. Subsurface Data from 105/107 E. Stratford in Map Region 73

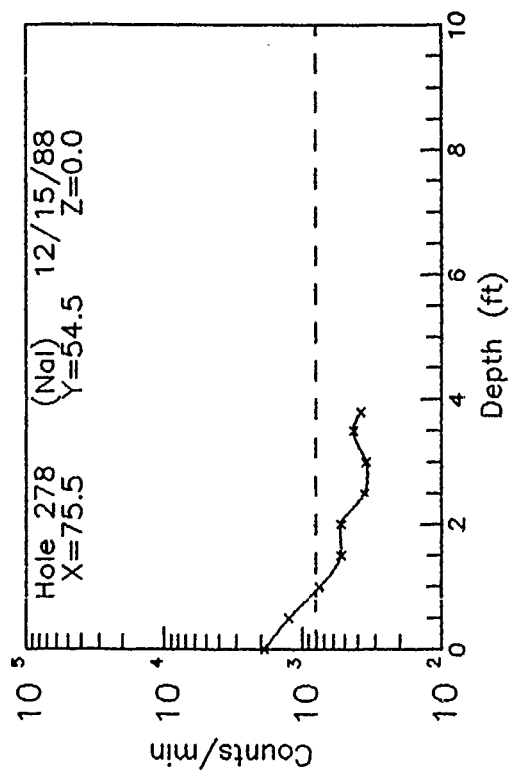
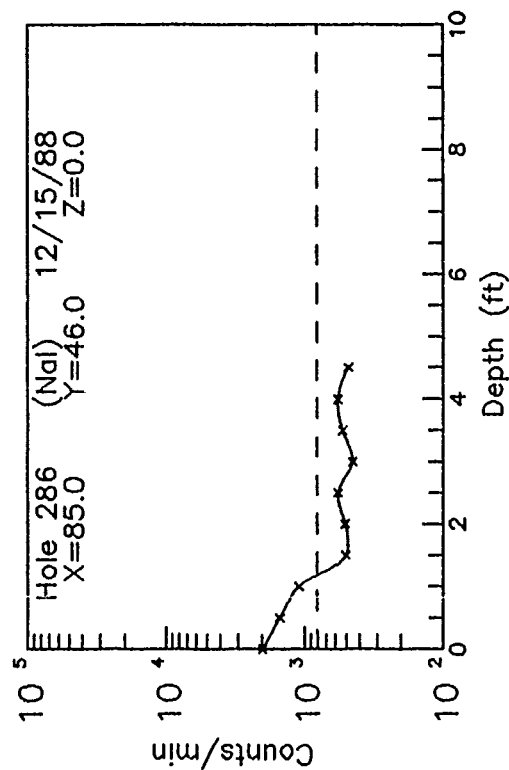
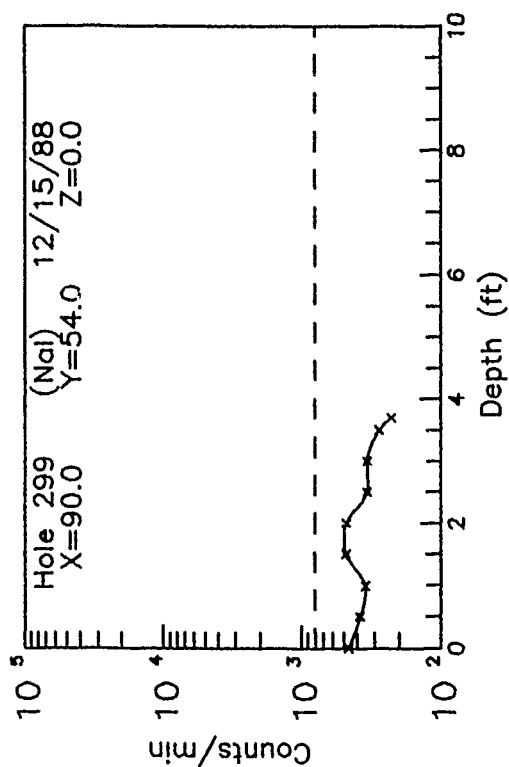
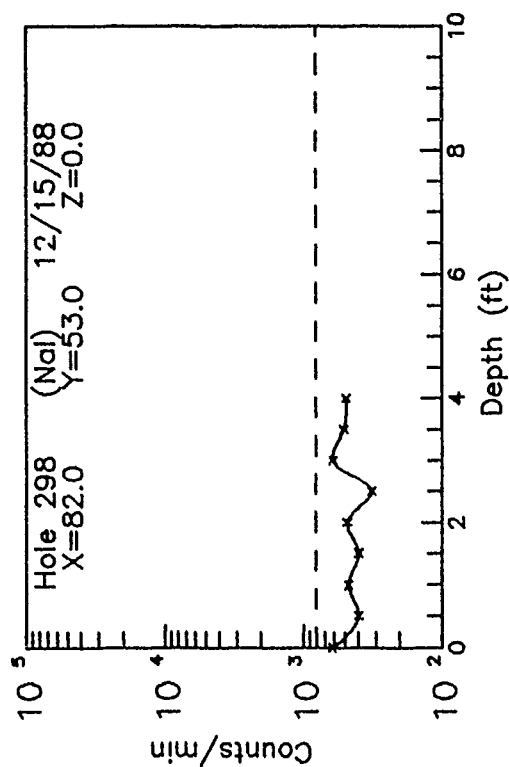


Figure C85. Subsurface Data from 105/107 E. Stratford in Map Region 74

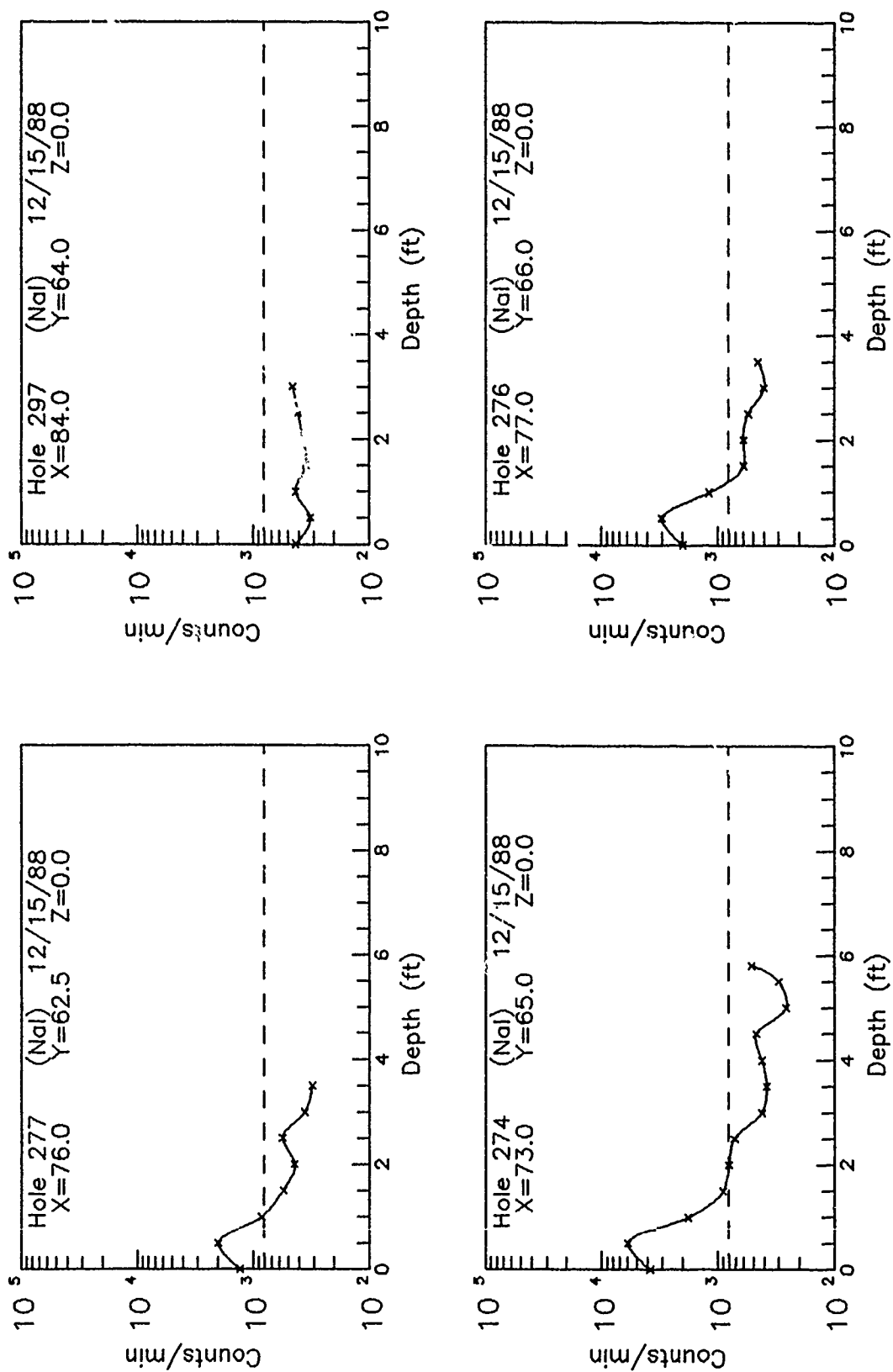


Figure C86. Subsurface Data from 105/107 E. Stratford in Map Region 75

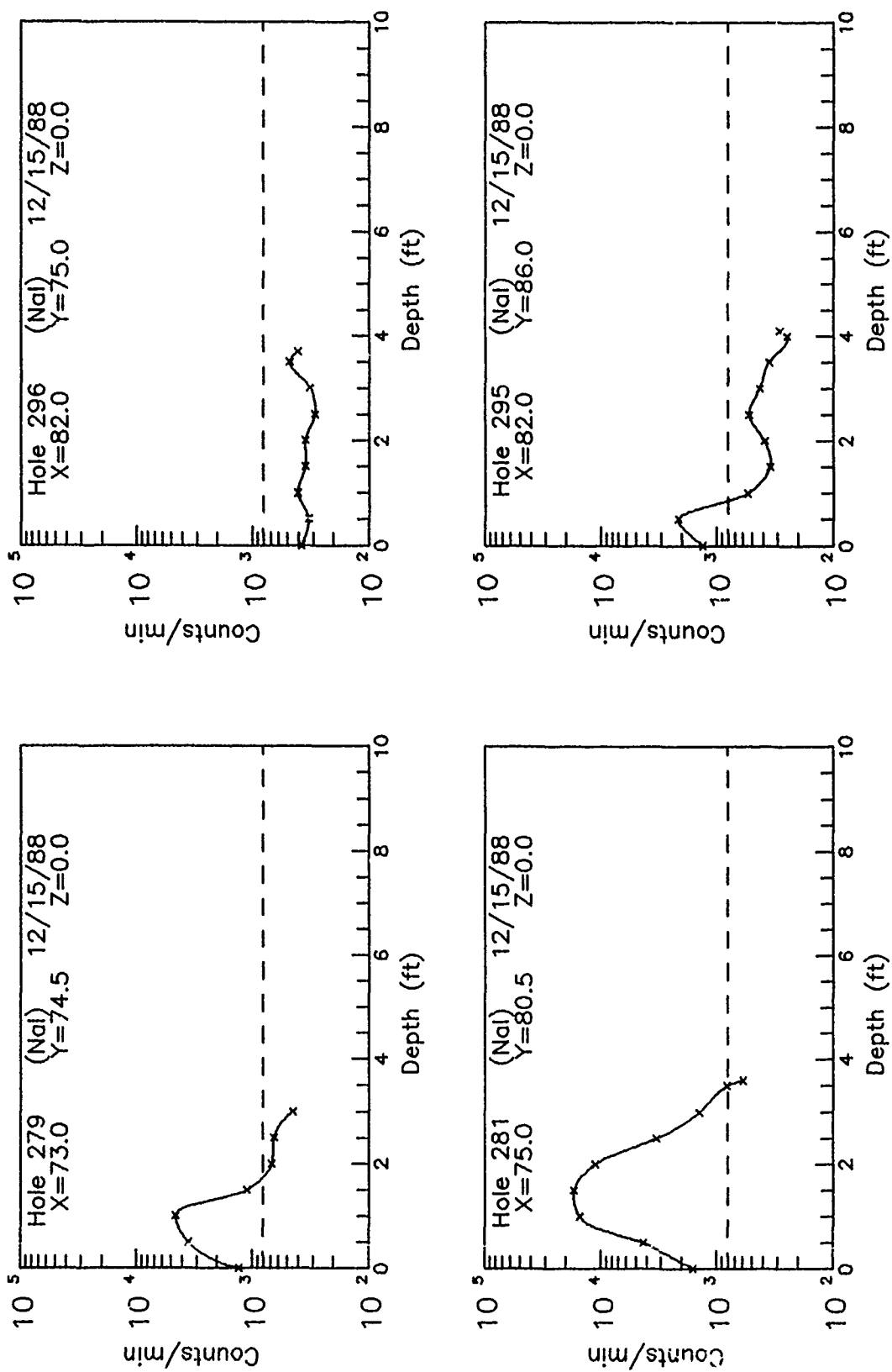


Figure C87. Subsurface Data from 105/107 E. Stratford in Map Region 76

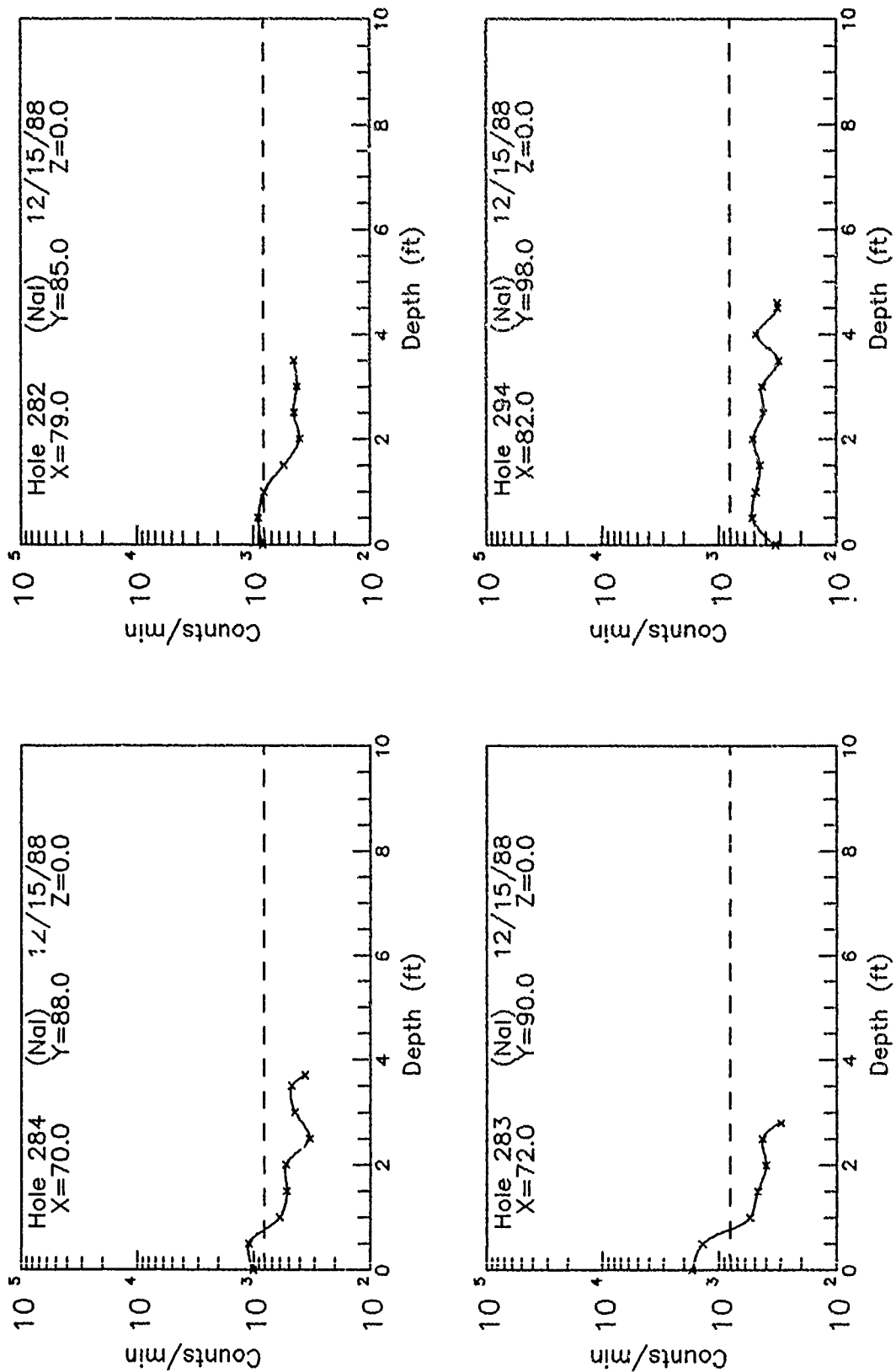


Figure C88. Subsurface Data from 105/107 E. Stratford in Map Region 77

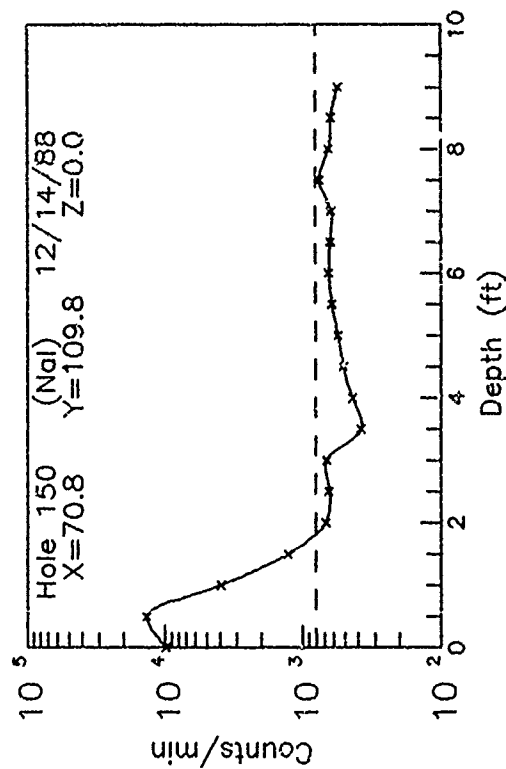
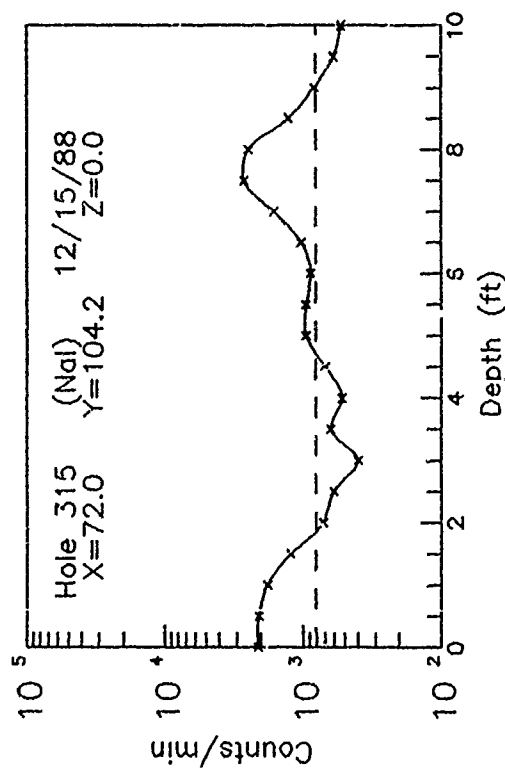
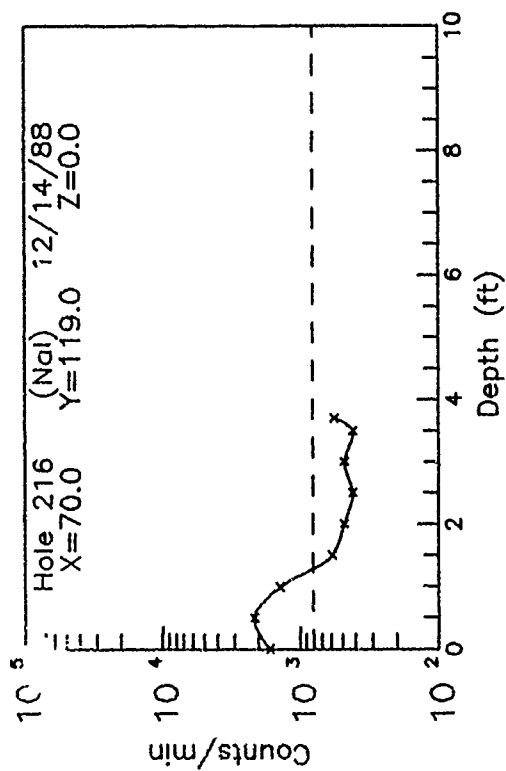
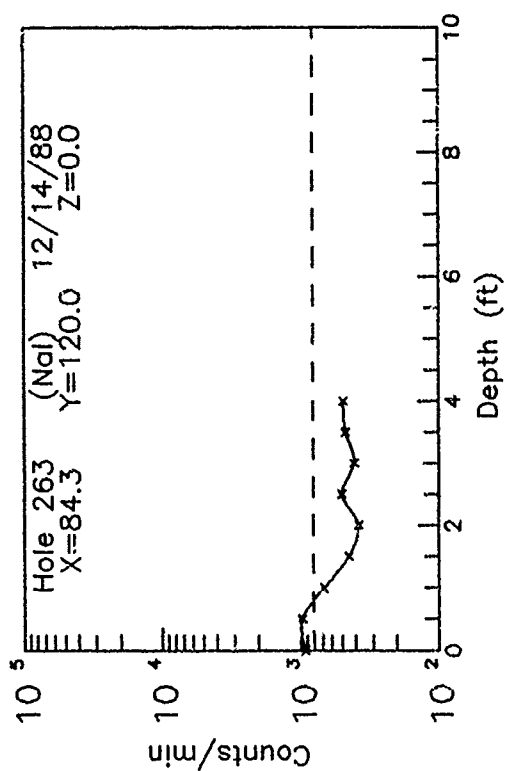


Figure C89. Subsurface Data from 105/107 E. Stratford in Map Region 78

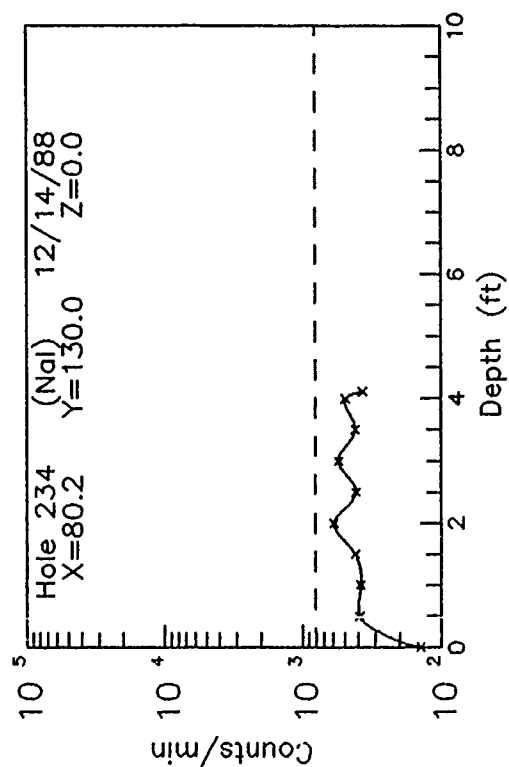
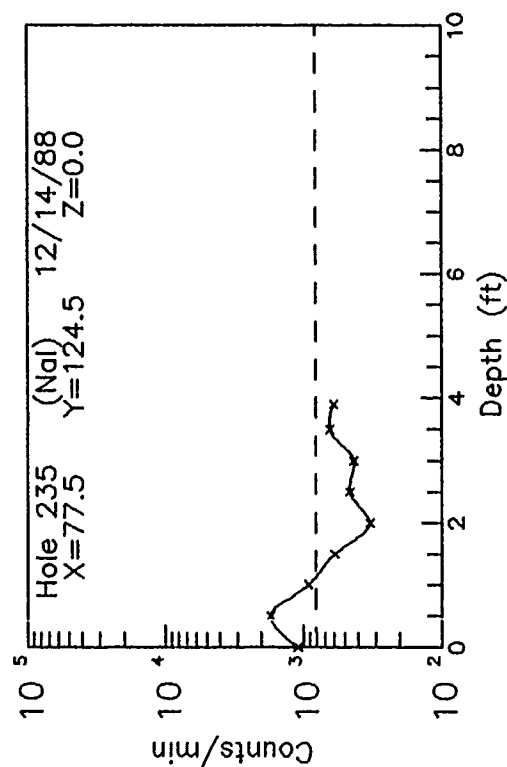
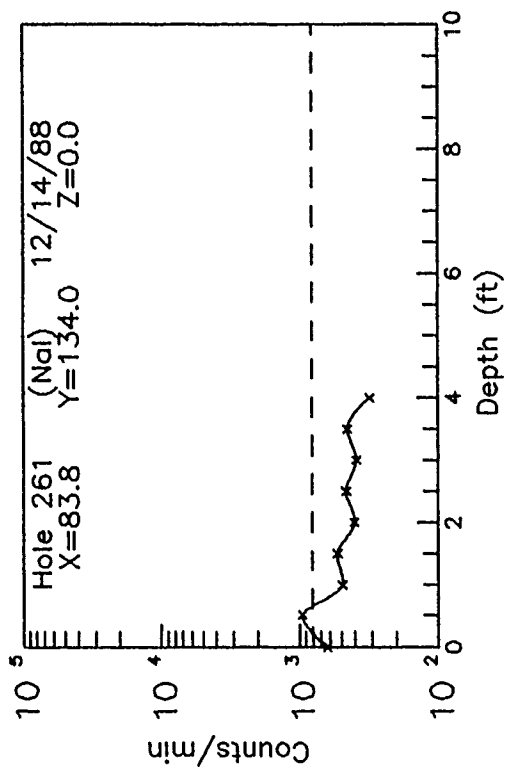
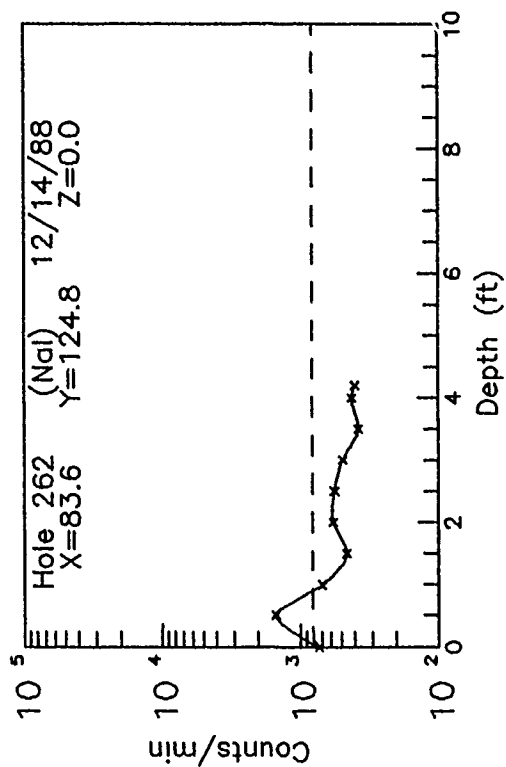


Figure C90. Subsurface Data from 105/107 E. Stratford in Map Region 79

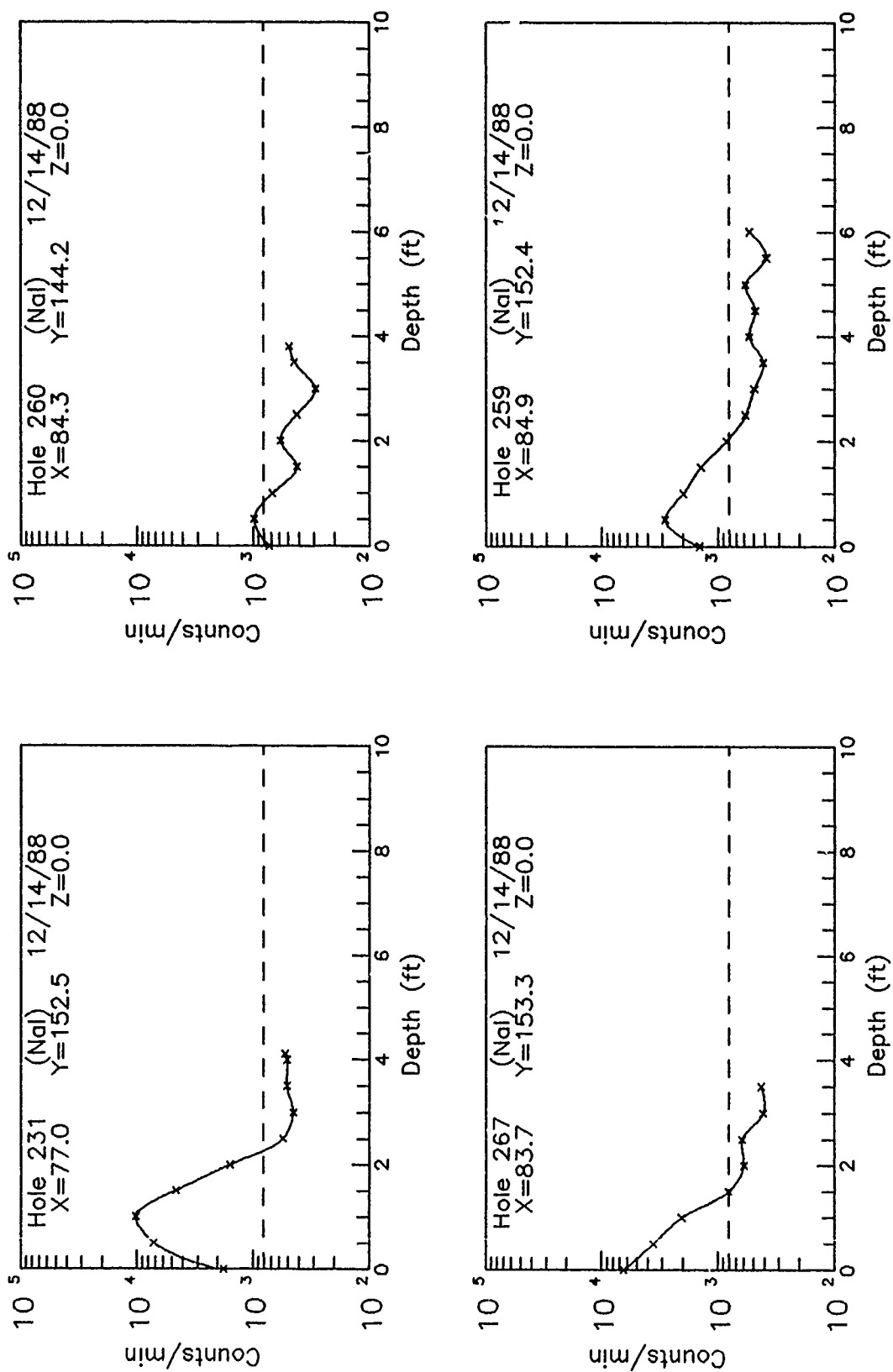


Figure C91. Subsurface Data from 107 E. Stratford in Map Region 80

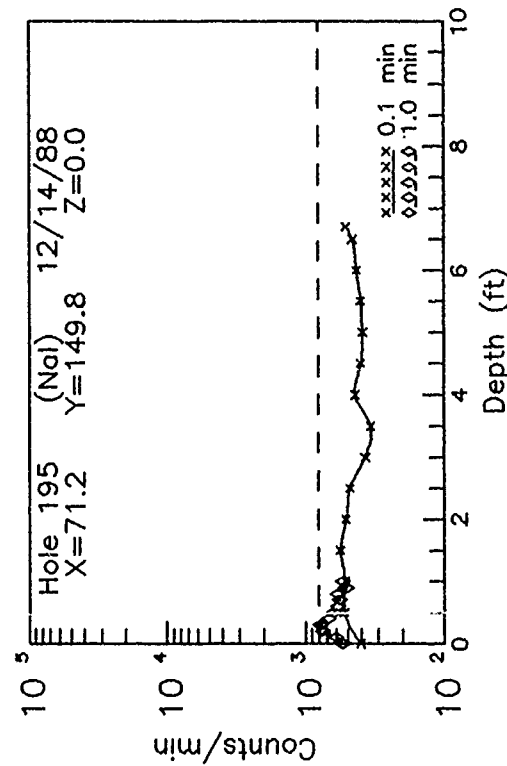
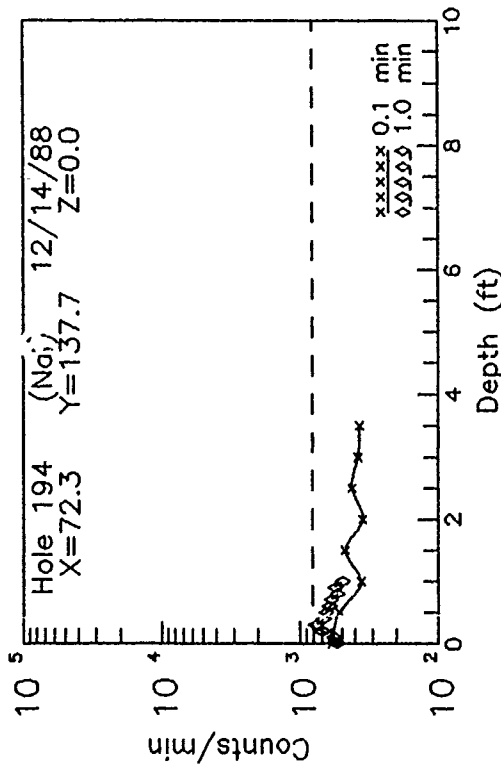
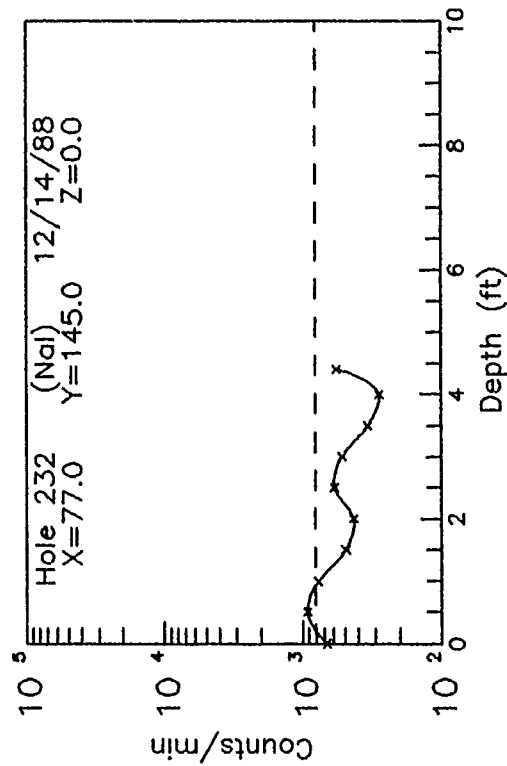
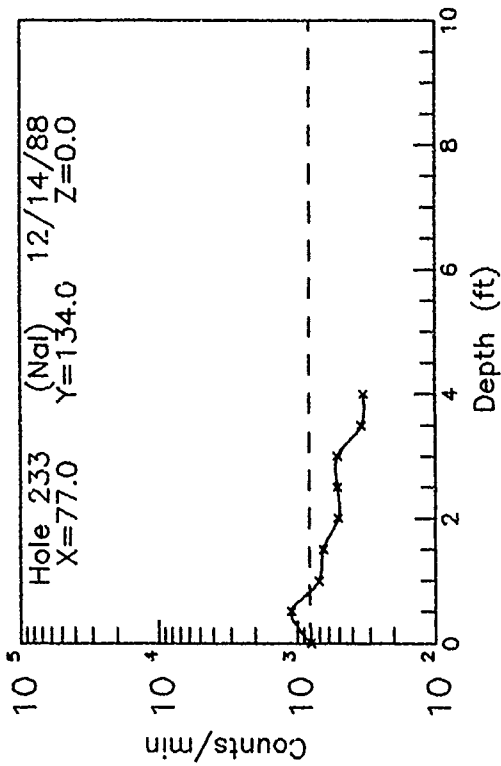


Figure C92. Subsurface Data from 105/107 E. Stratford in Map Region 81

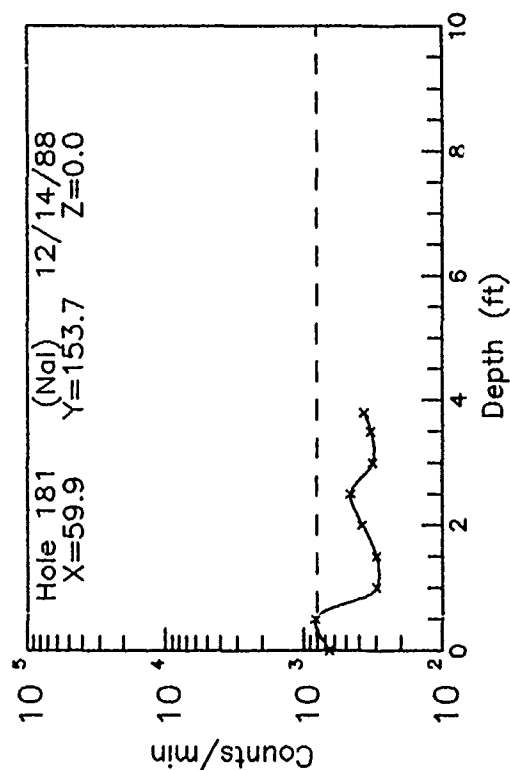
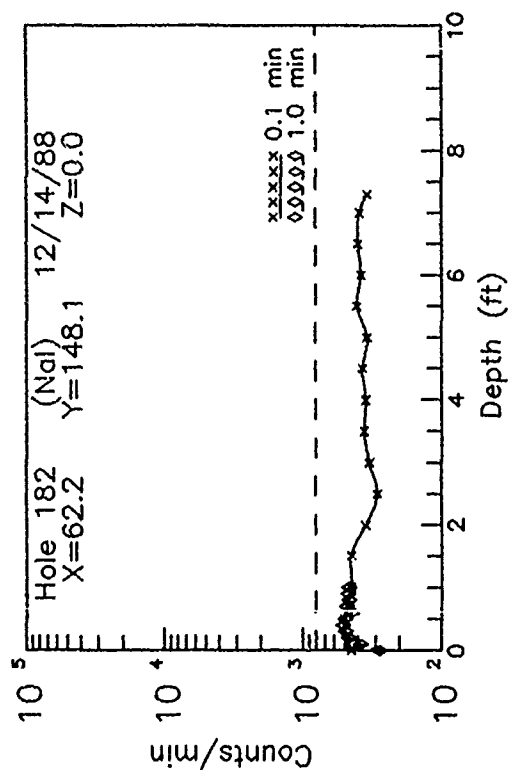
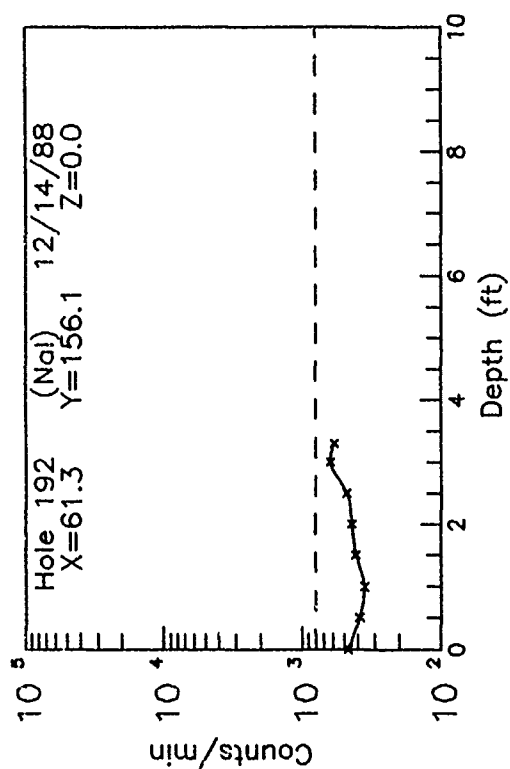
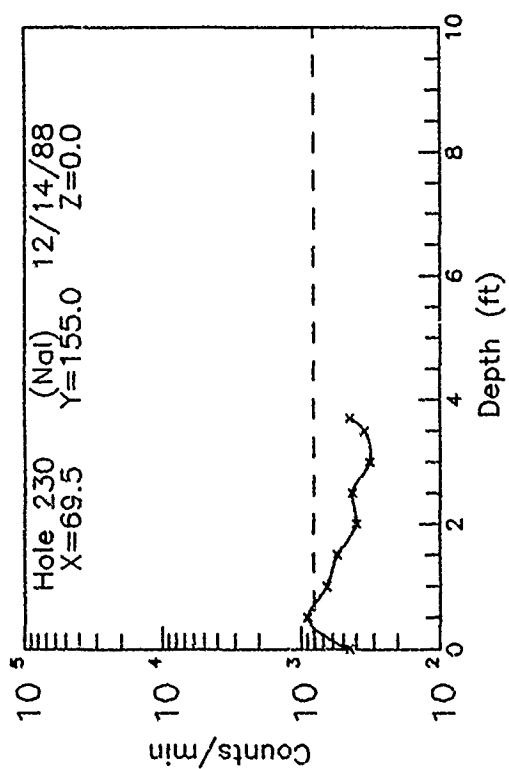


Figure C93. Subsurface Data from 105/107 E. Stratford in Map Region 82

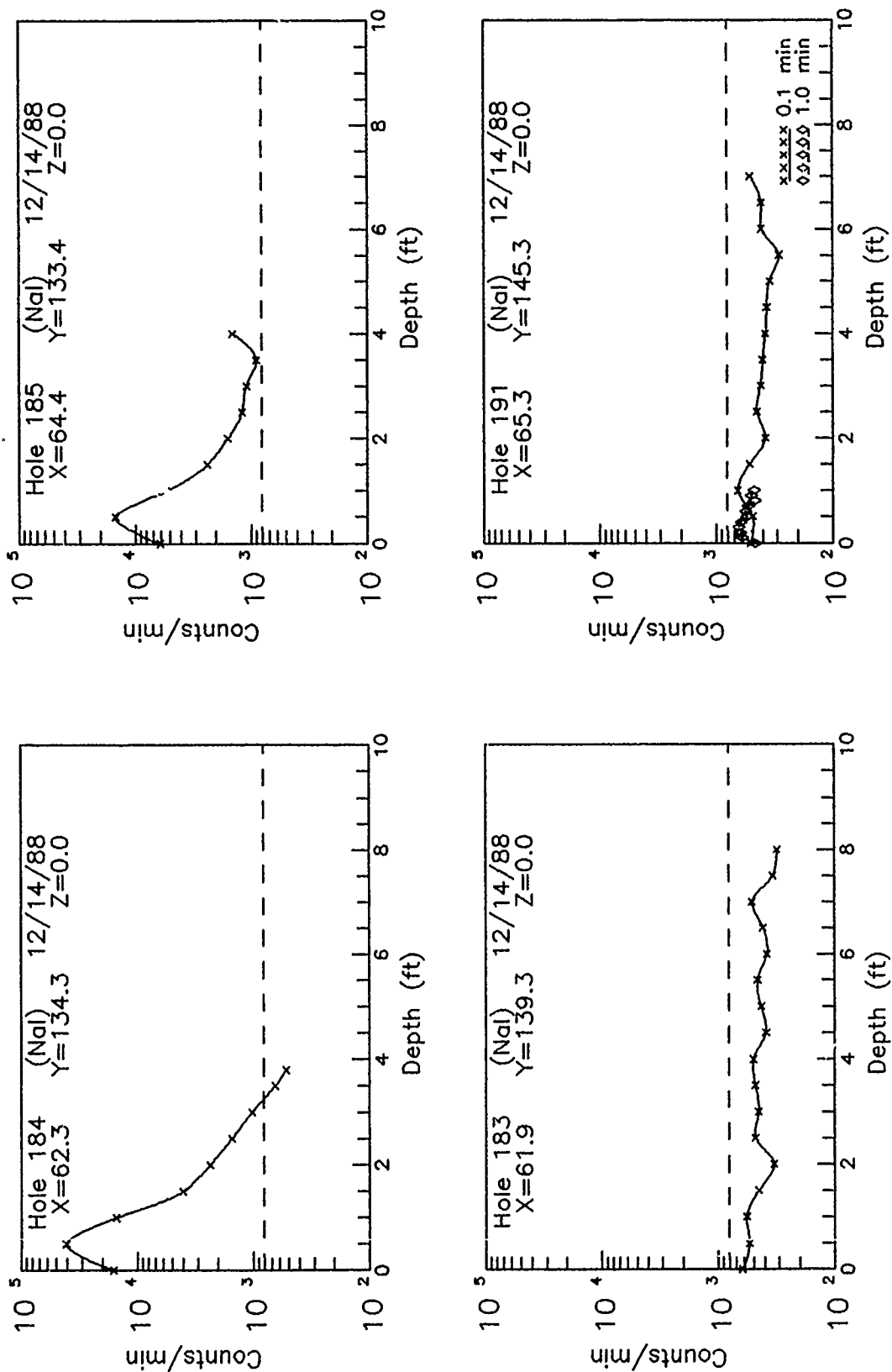


Figure C94. Subsurface Data from 105 E. Stratford in Map Region 83

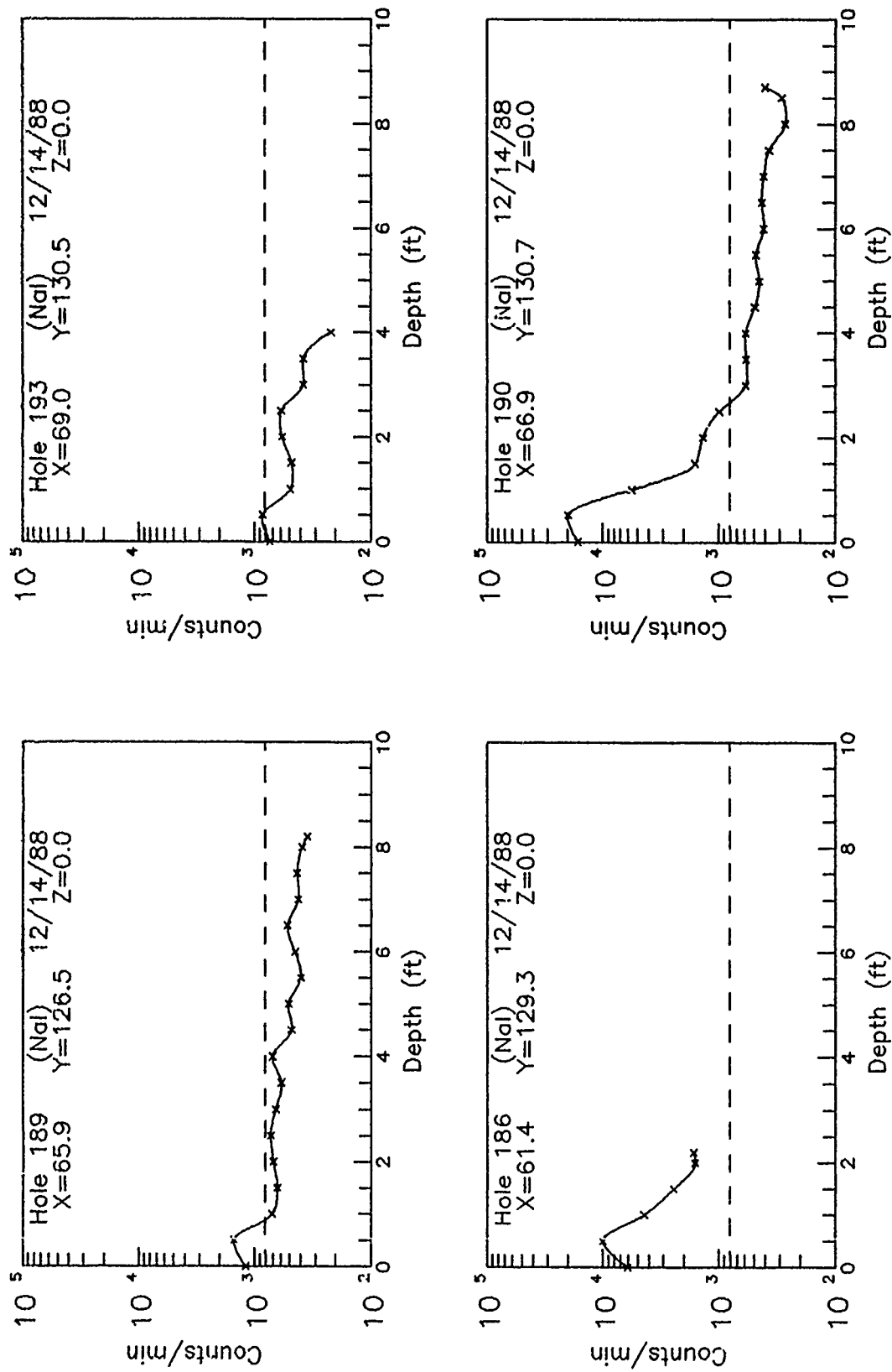


Figure C95. Subsurface Data from 105 E. Stratford in Map Region 84

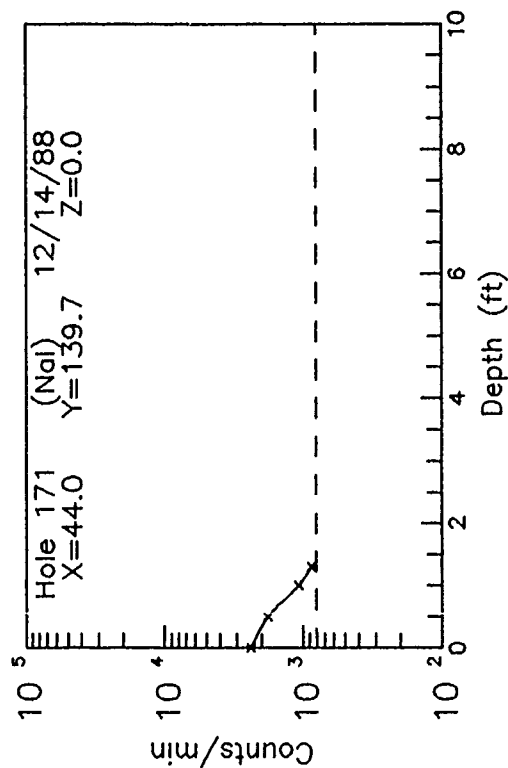
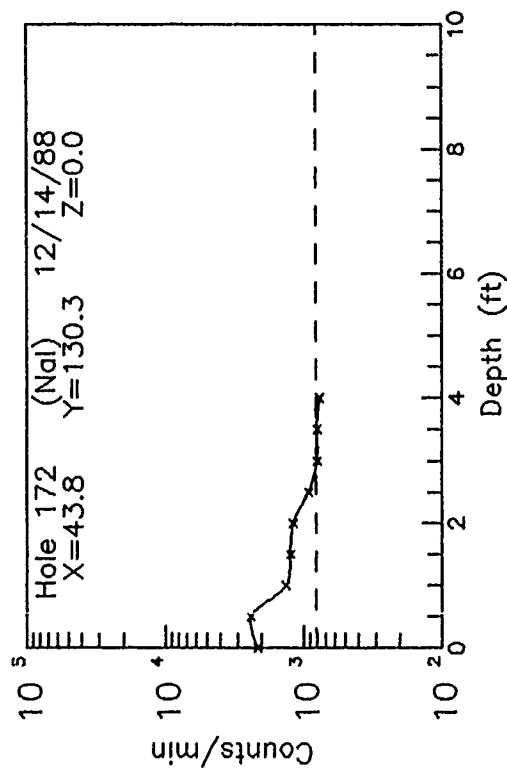
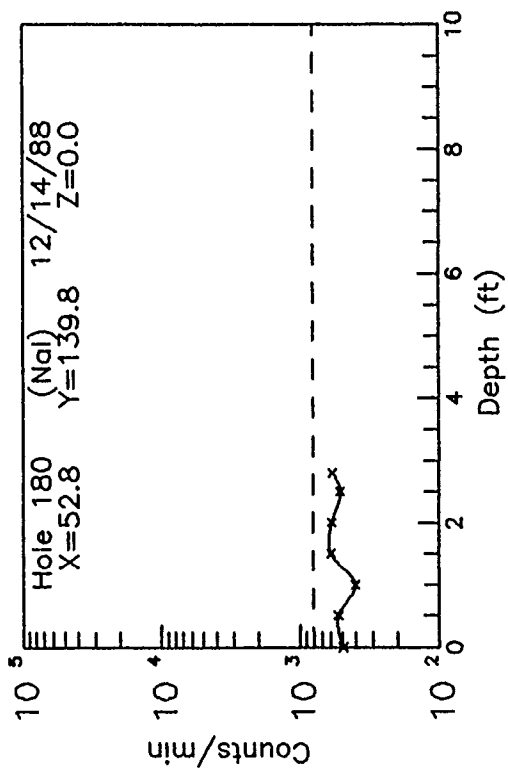
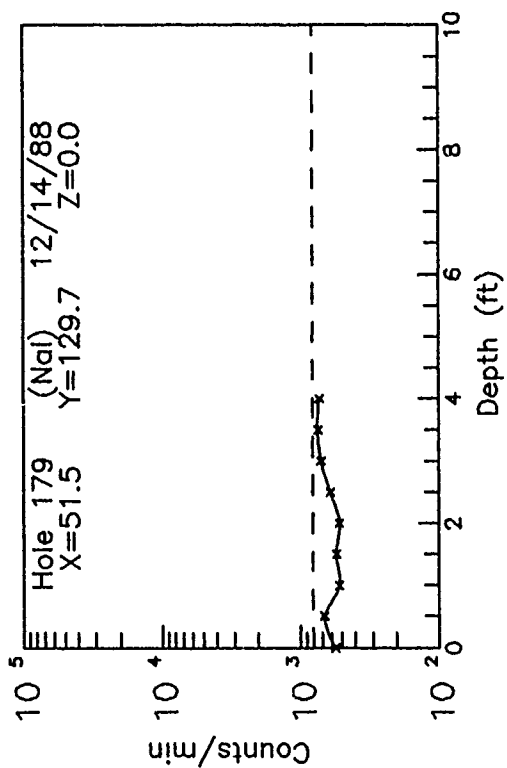


Figure C96. Subsurface Data from 105 E. Stratford in Map Region 85

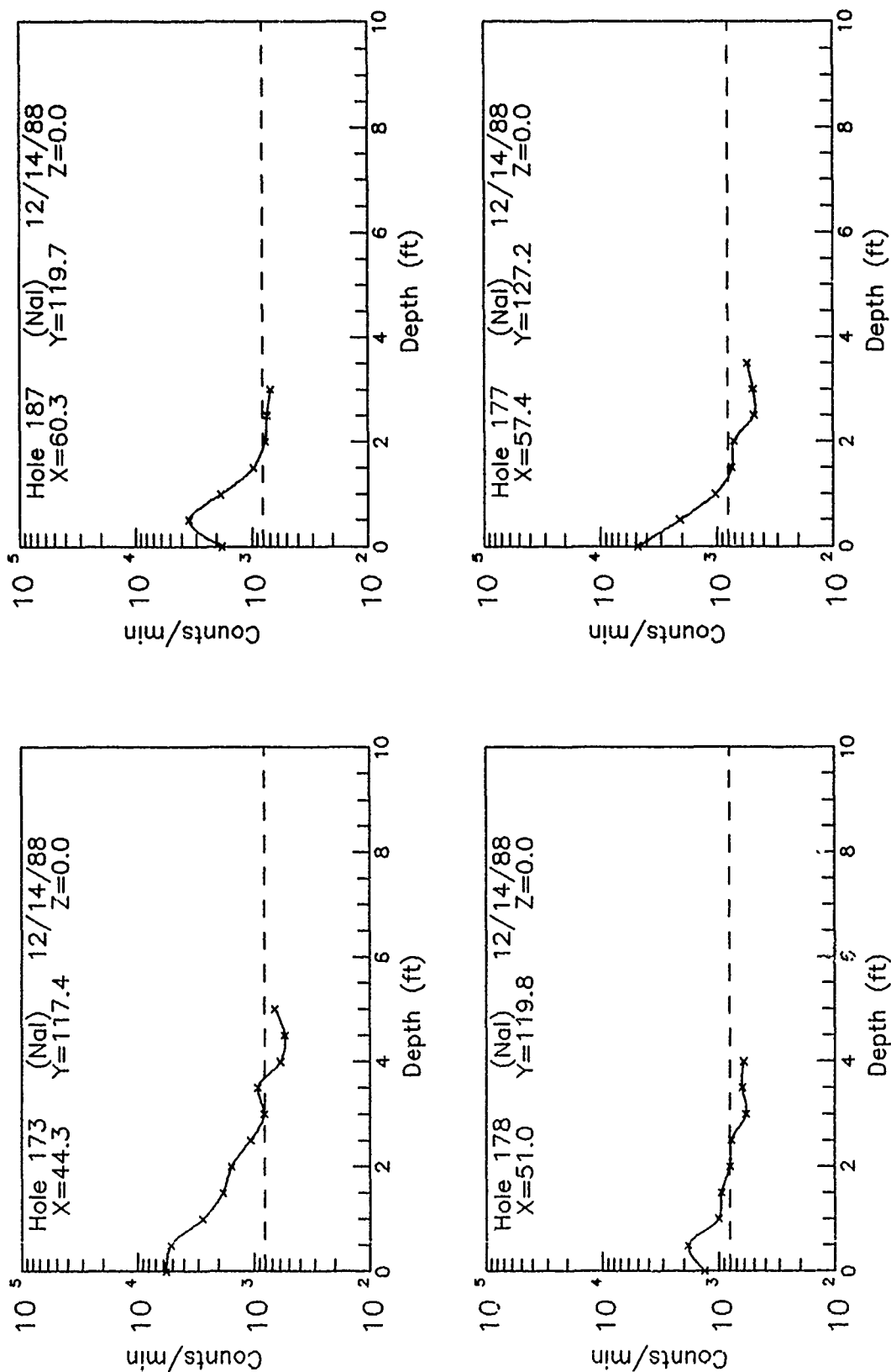


Figure C97. Subsurface Data from 105 E. Stratford in Map Region 86

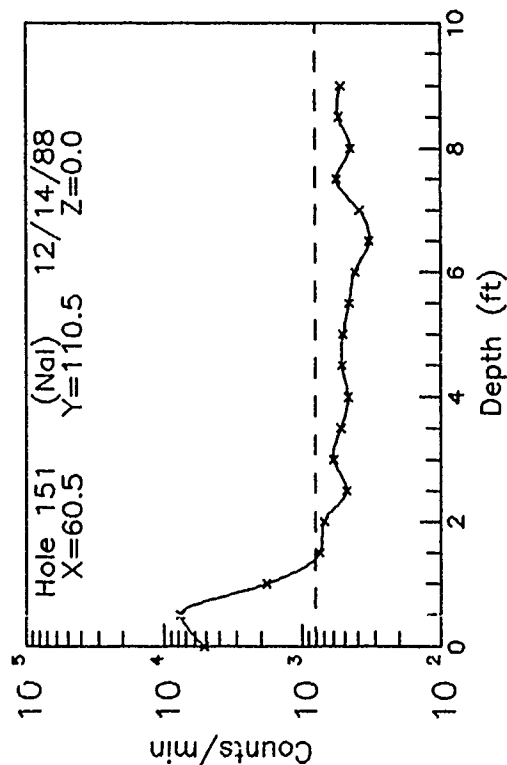
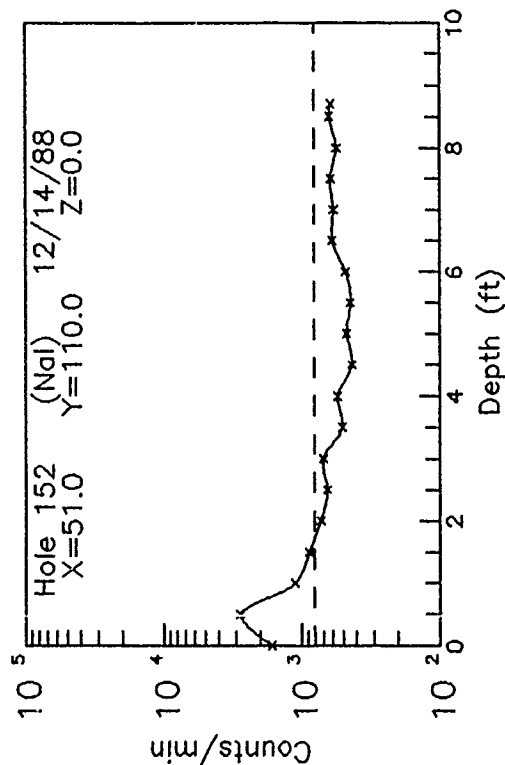
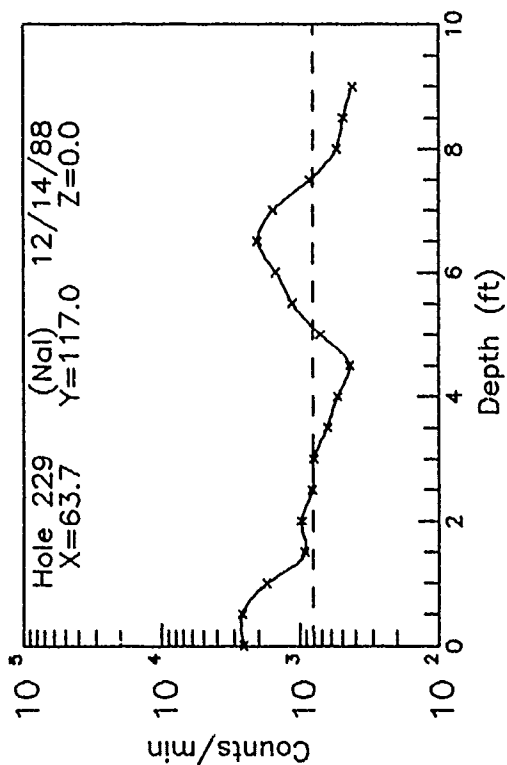
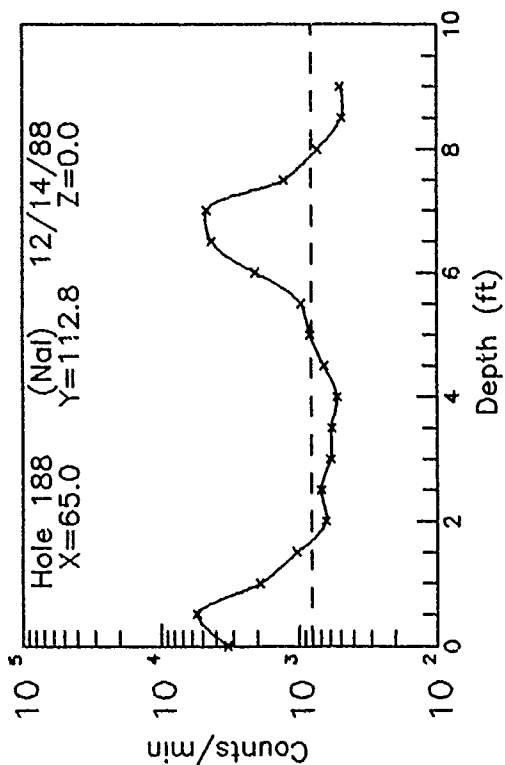


Figure C98. Subsurface Data from 105 E. Stratford in Map Region 87

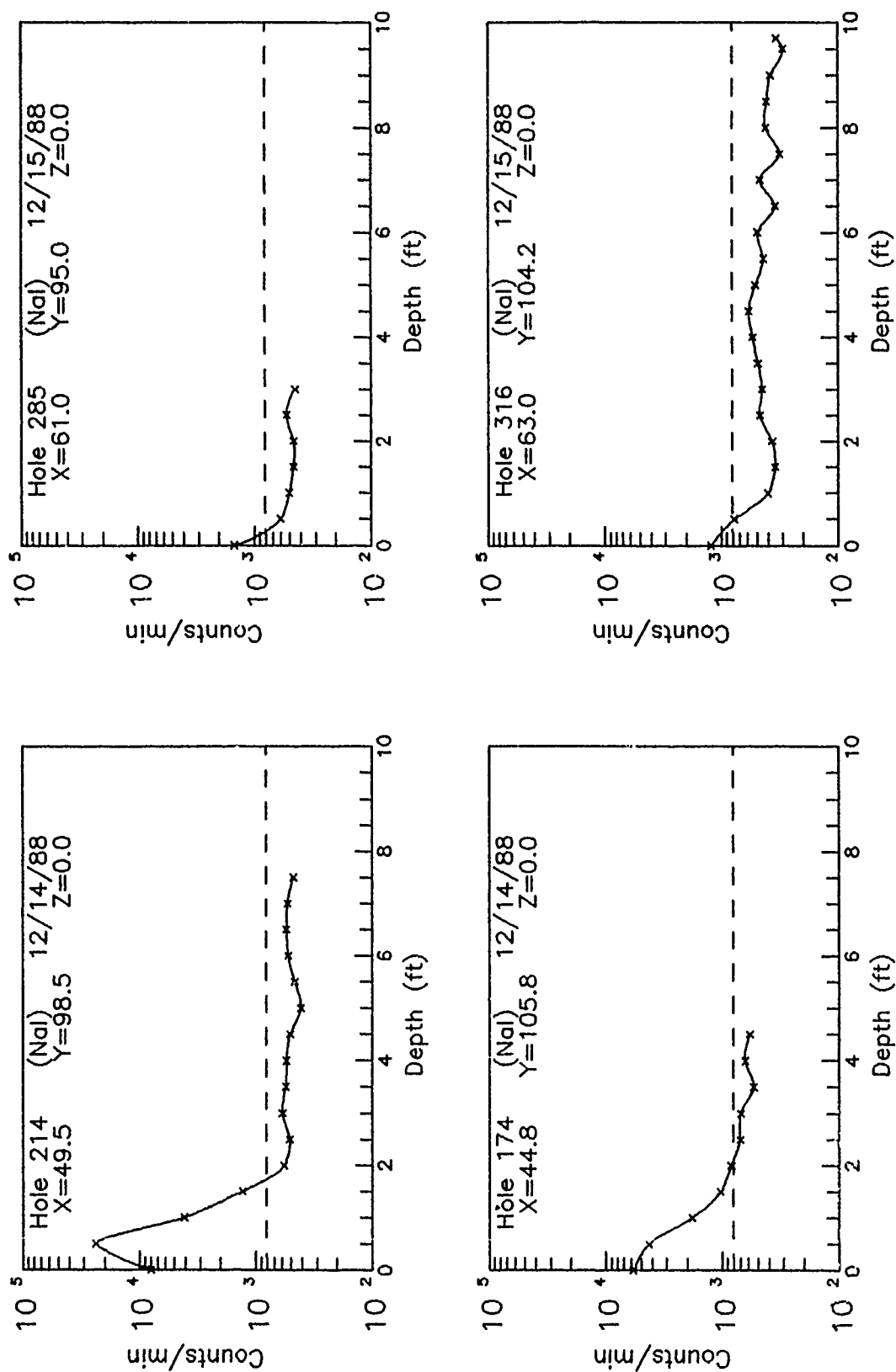


Figure C99. Subsurface Data from 105 E. Stratford in Map Region 88

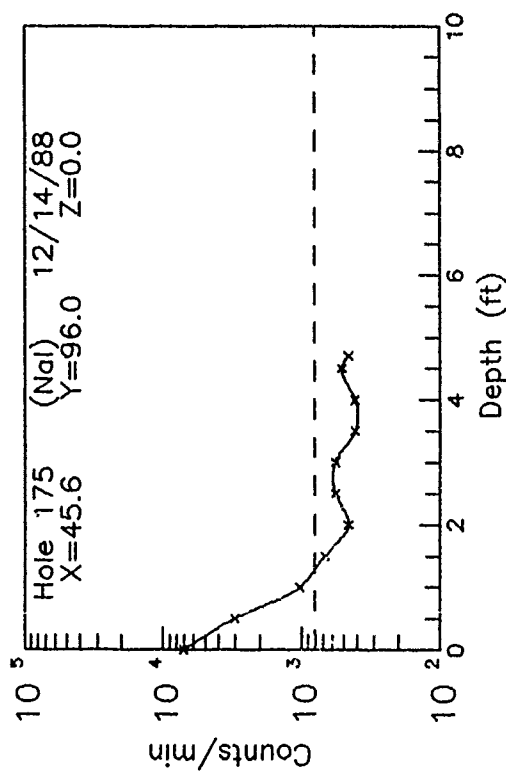
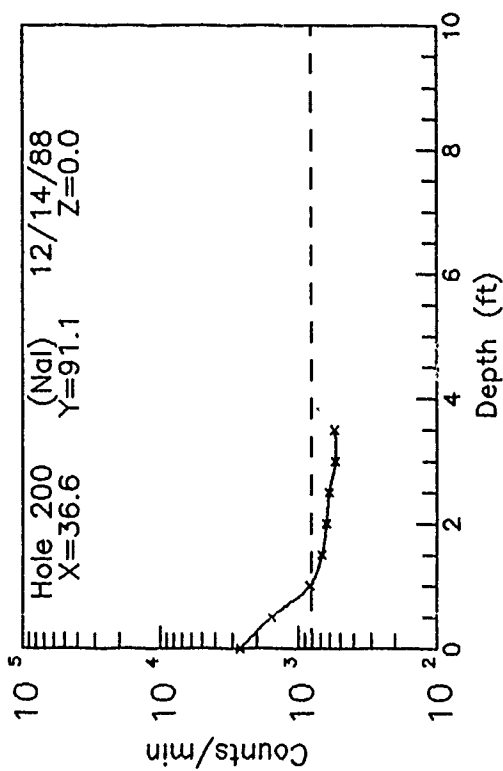
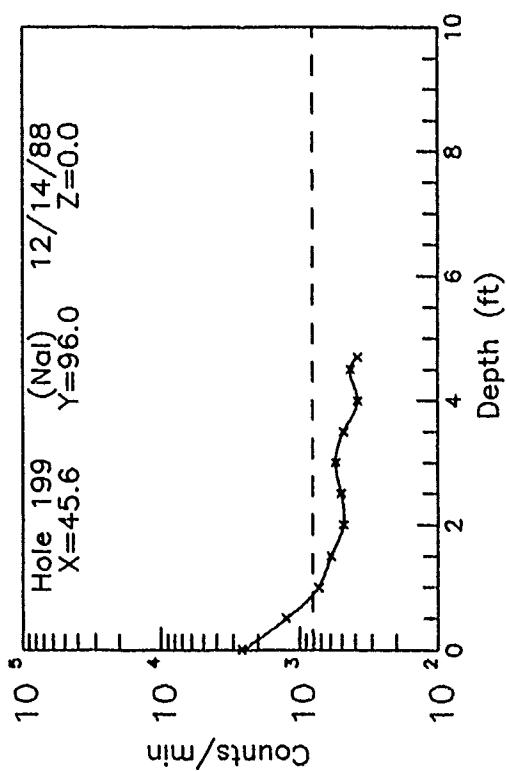
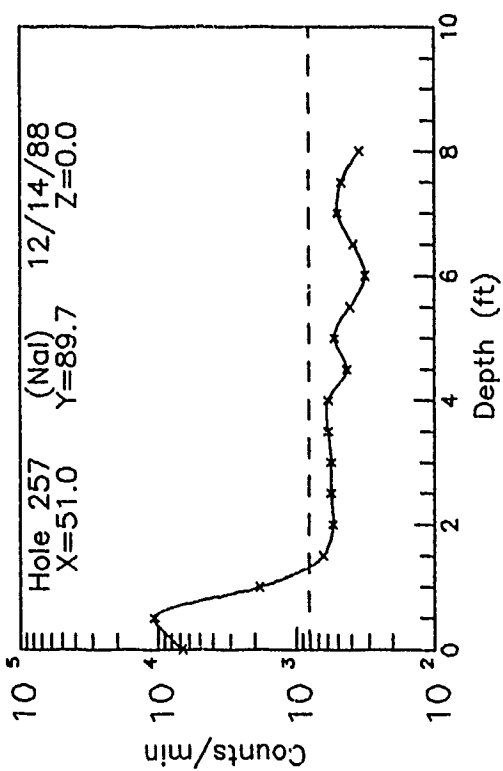


Figure C100. Subsurface Data from 105 E. Stratford in Map Region 89

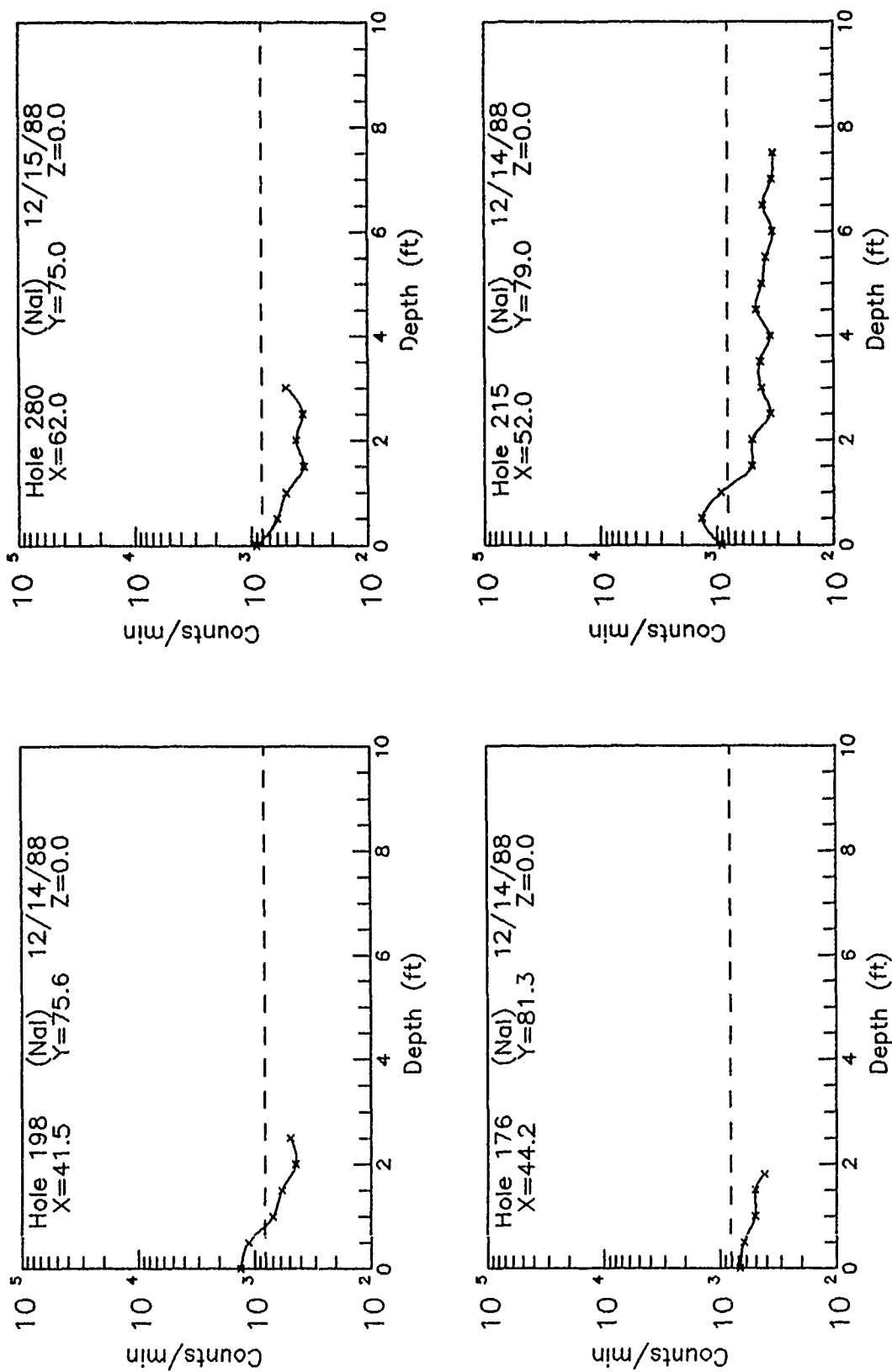


Figure C101. Subsurface Data from 105 E. Stratford in Map Region 90

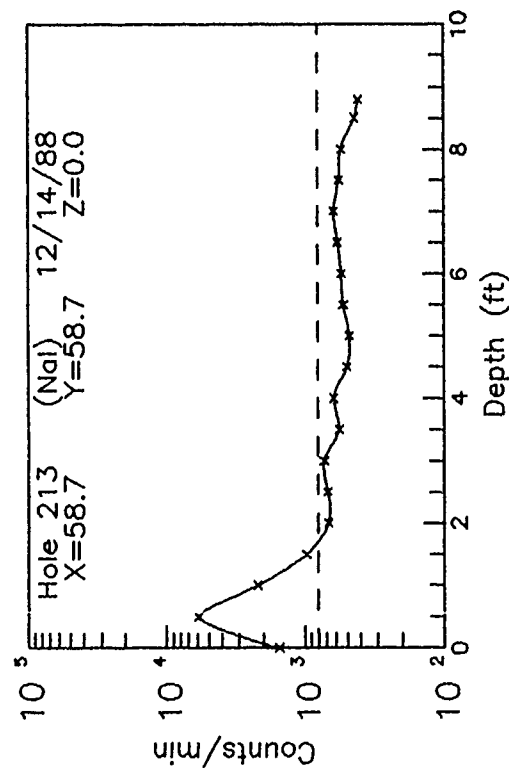
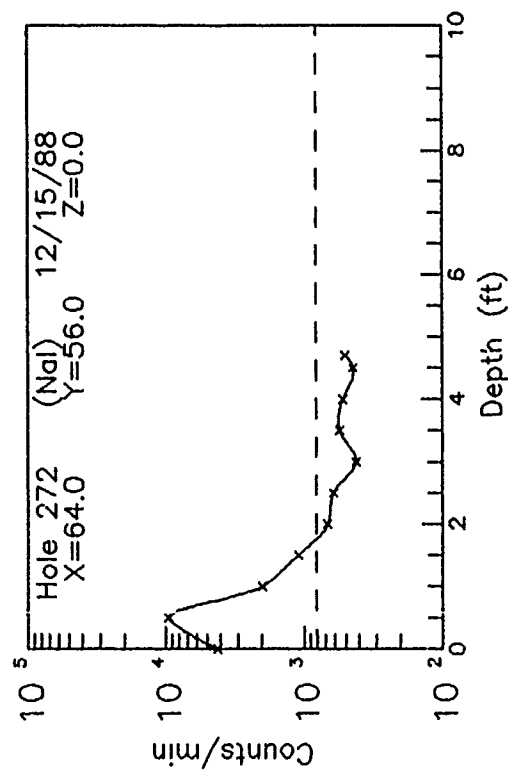
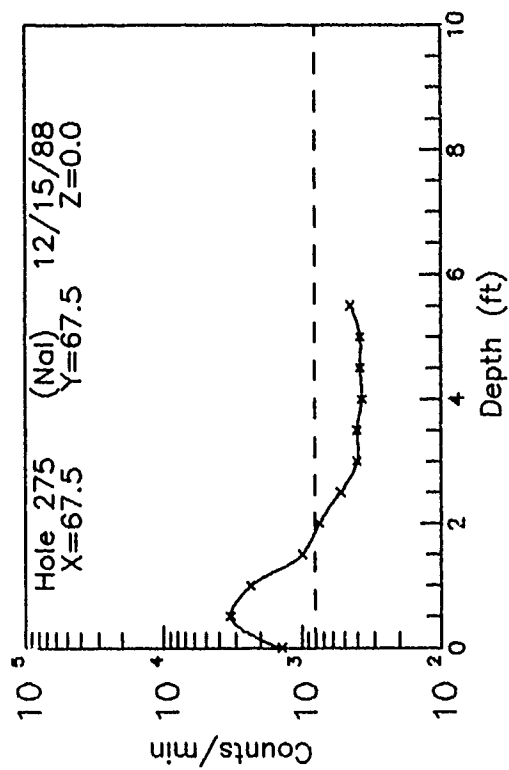
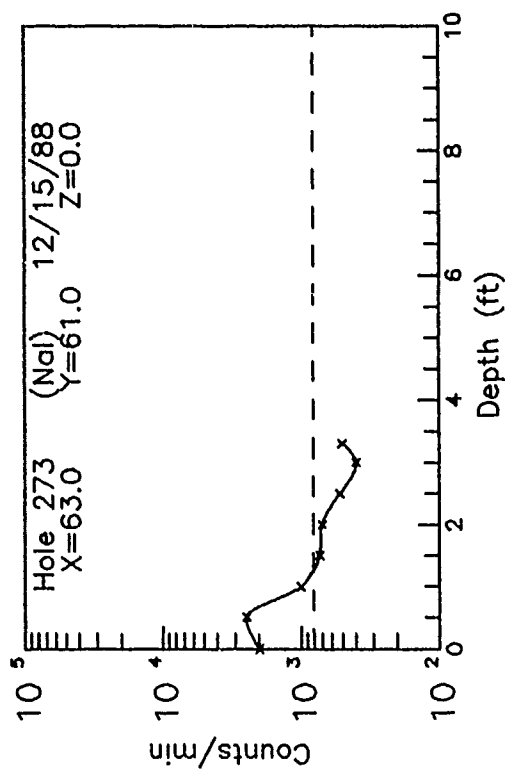


Figure C102. Subsurface Data from 105 E. Stratford in Map Region 91

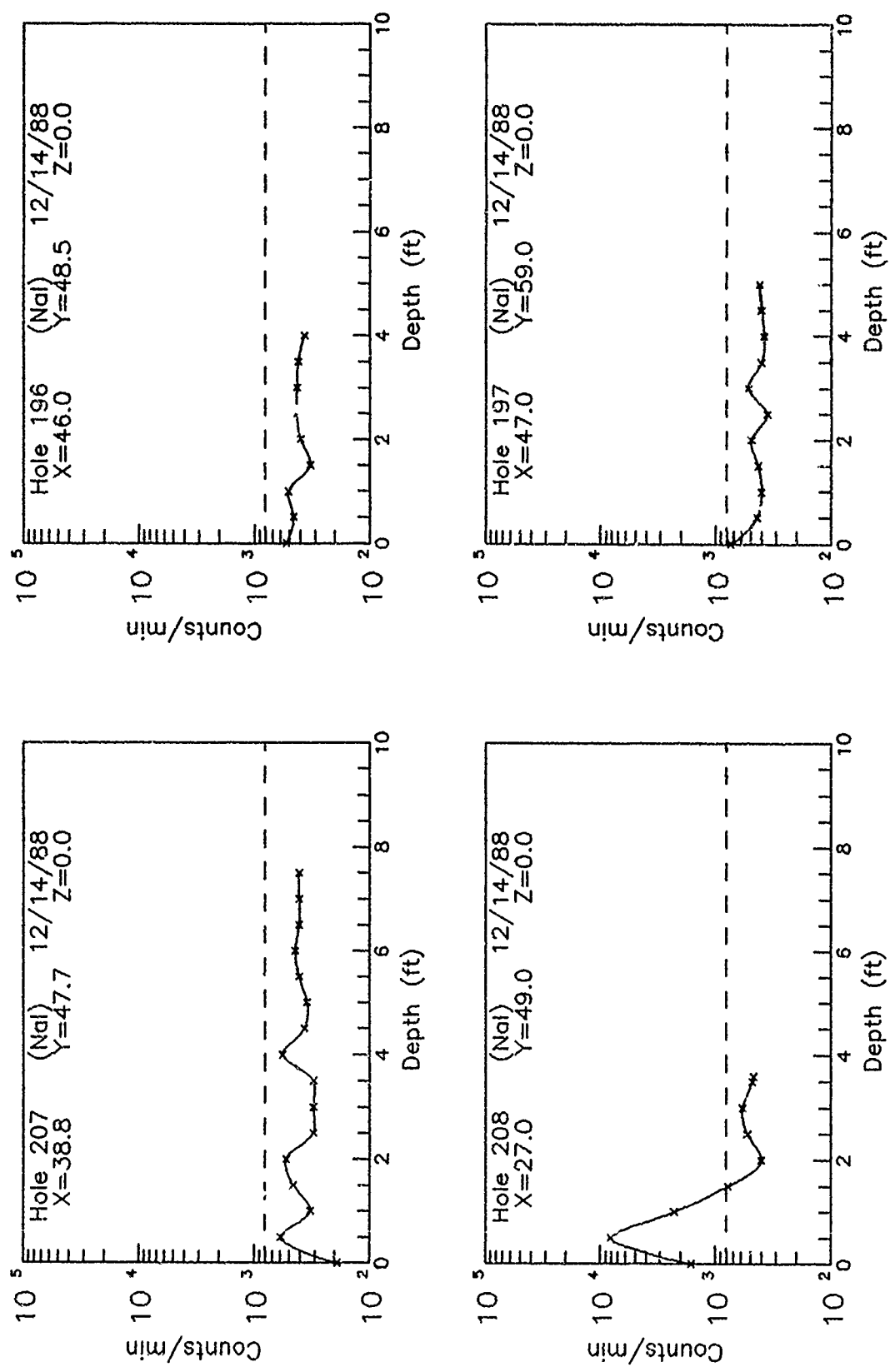


Figure C103. Subsurface Data from 105 E. Stratford in Map Region 92

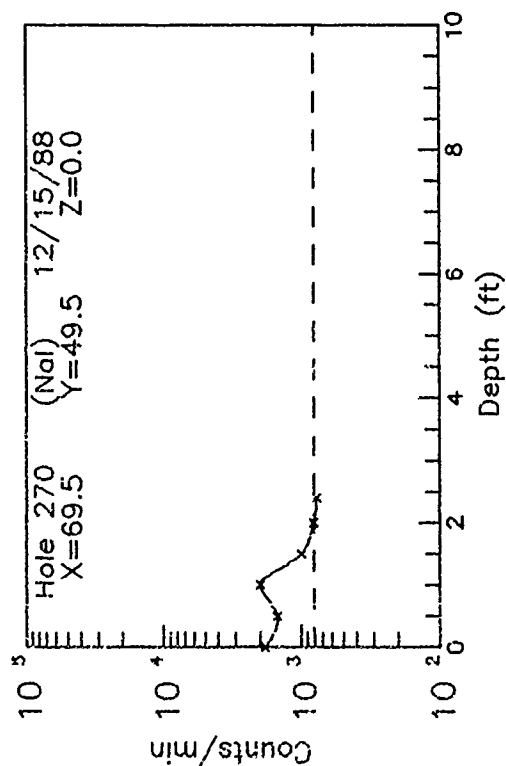
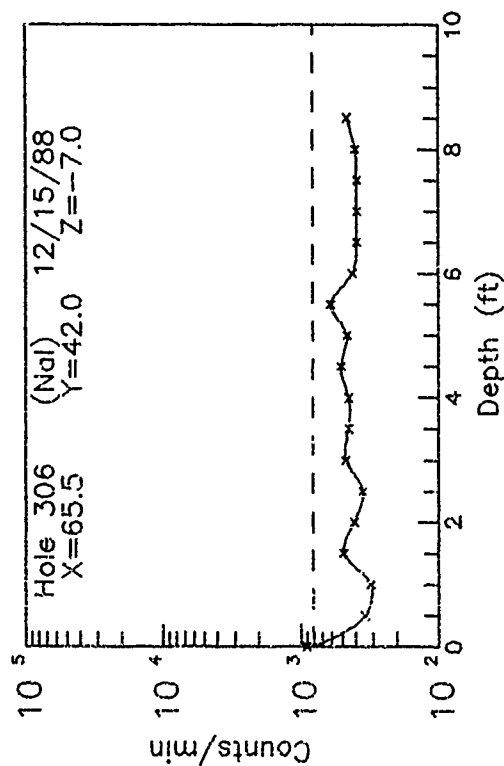
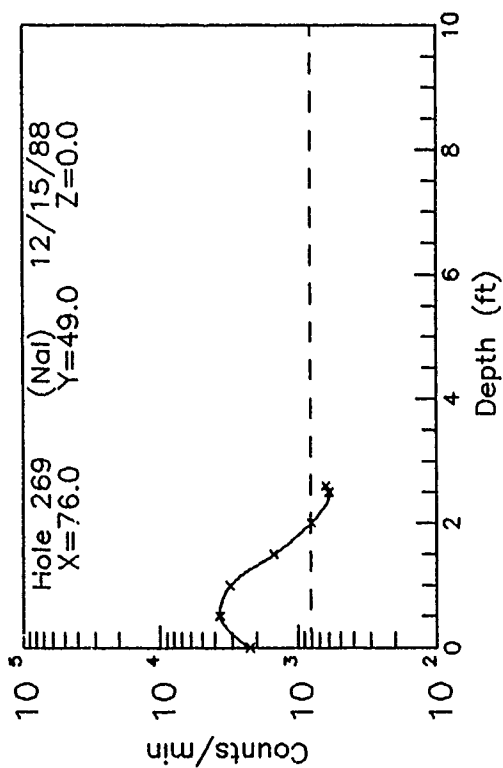
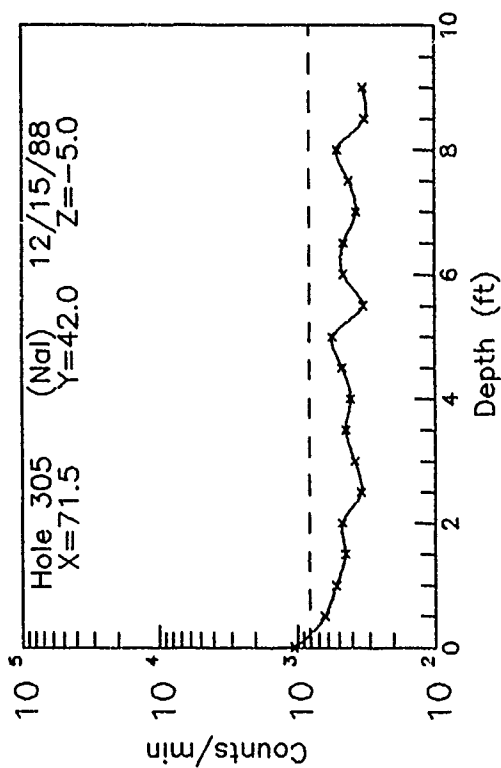


Figure C104. Subsurface Data from 105 E. Stratford in Map Region 93

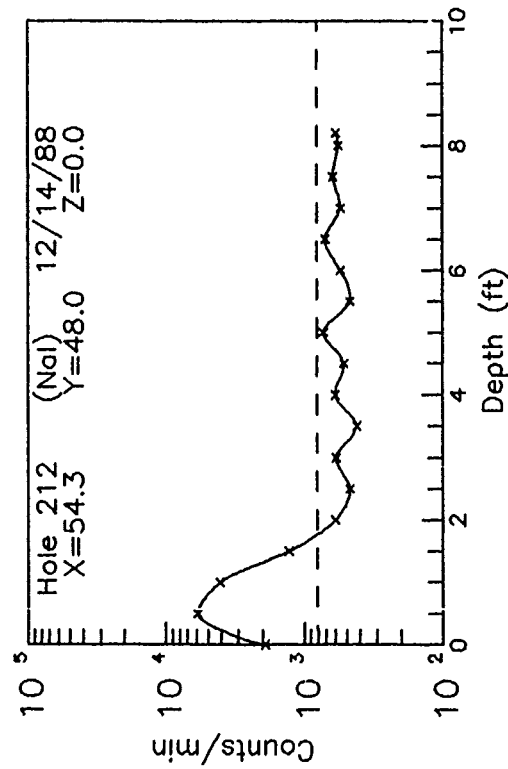
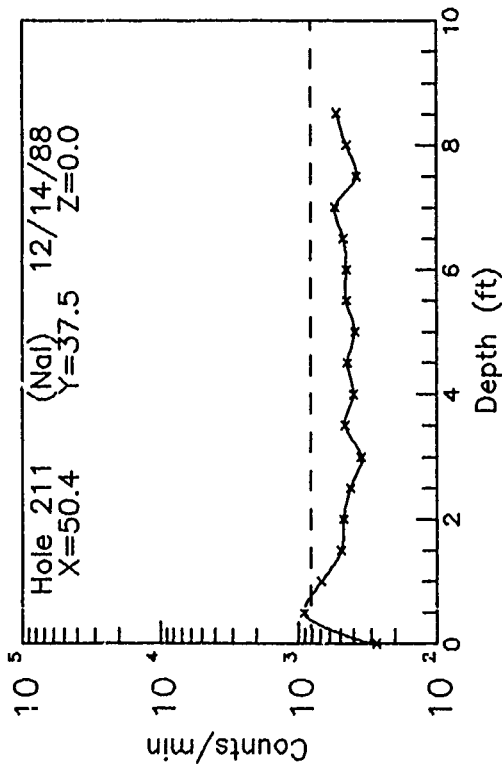
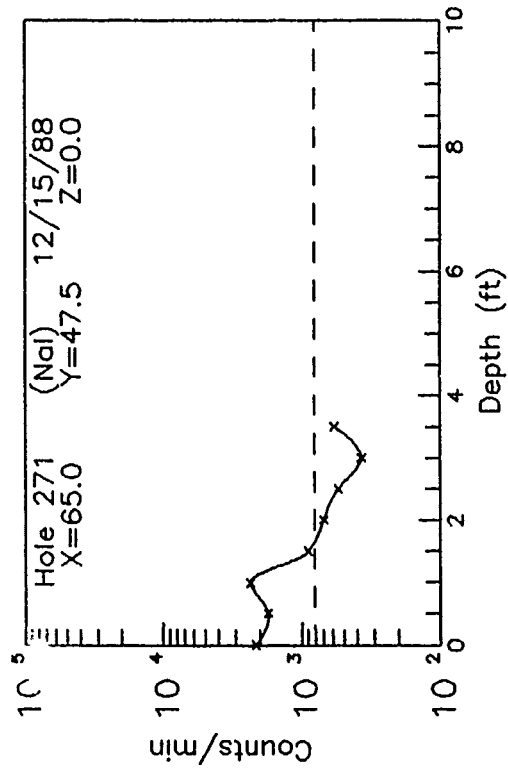
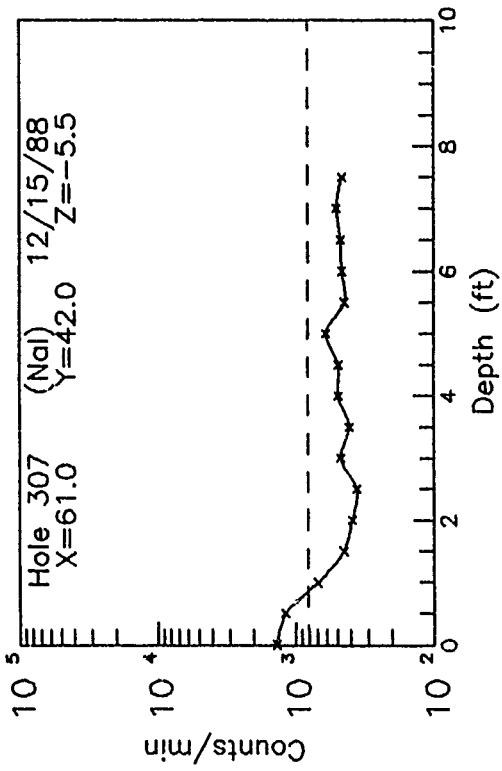


Figure C105. Subsurface Data from 105 E. Stratford in Map Region 94

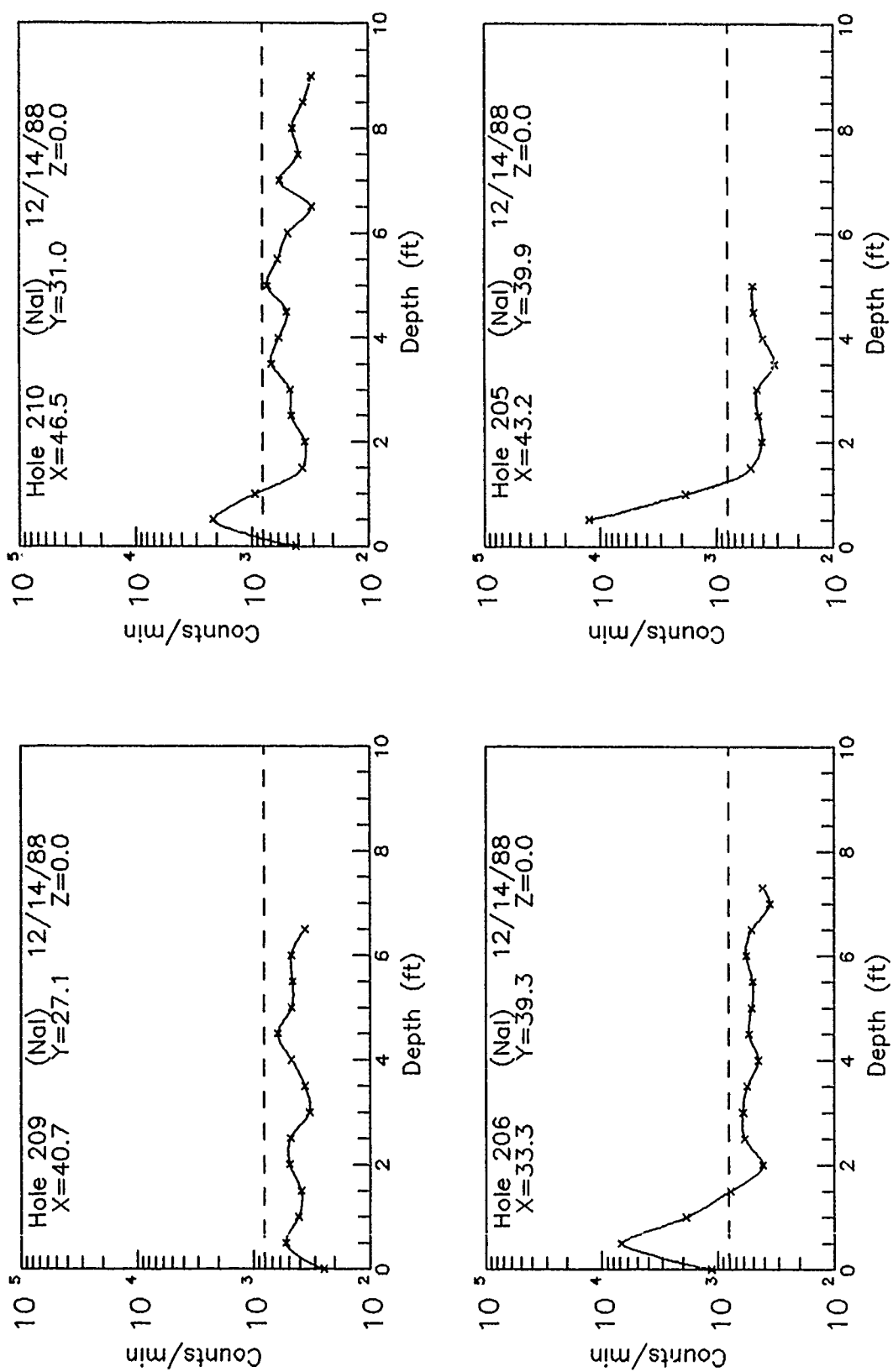


Figure C106. Subsurface Data from 105 E. Stratford in Map Region 95

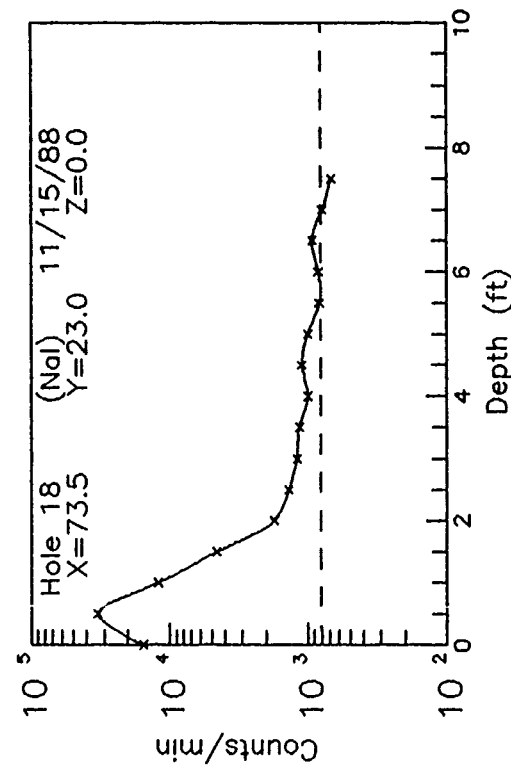
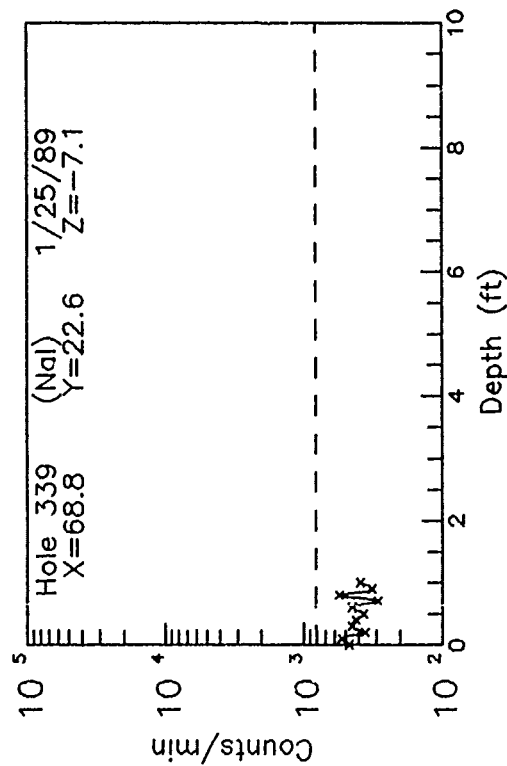
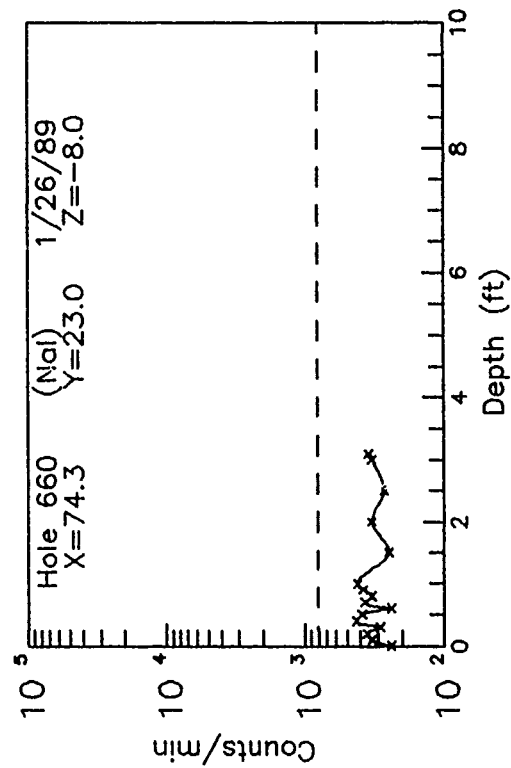
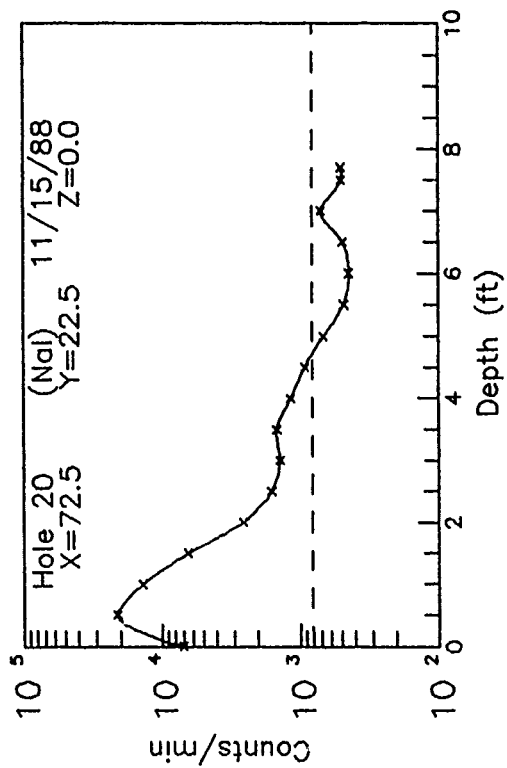


Figure C107. Subsurface Data from 105 E. Stratford in Map Region 96

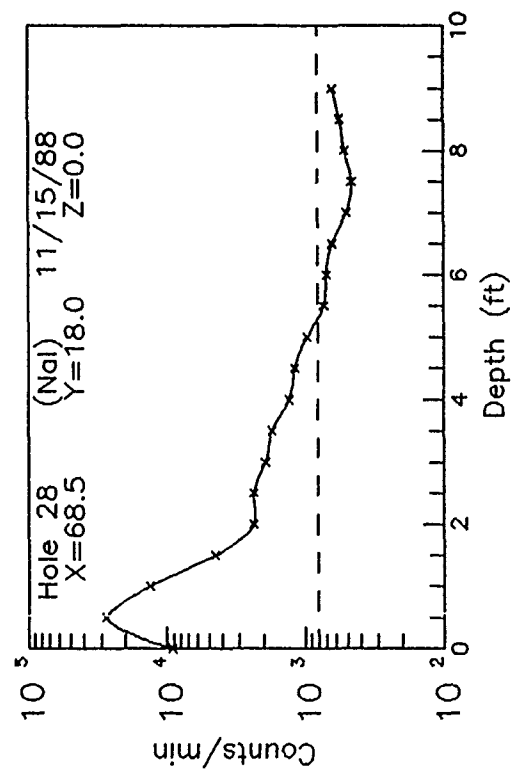
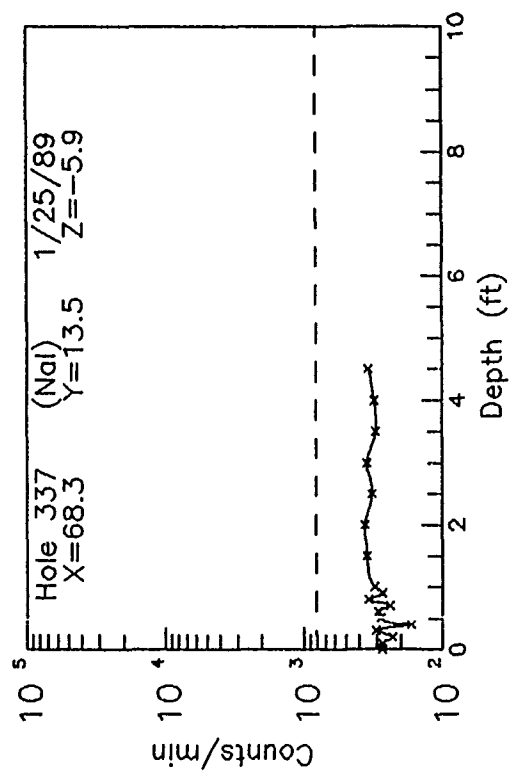
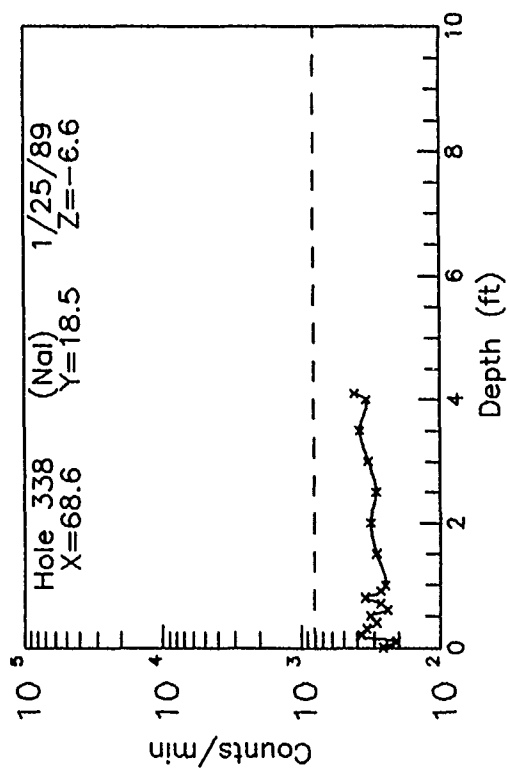
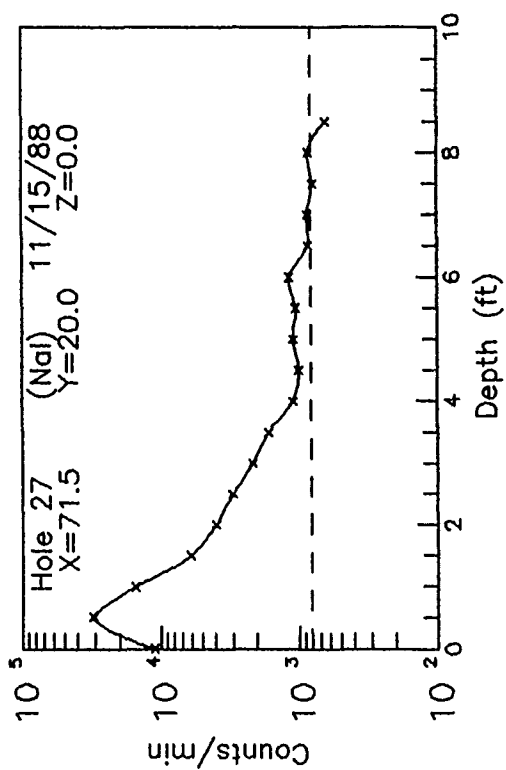


Figure C108. Subsurface Data from 105 E. Stratford in Map Region 97

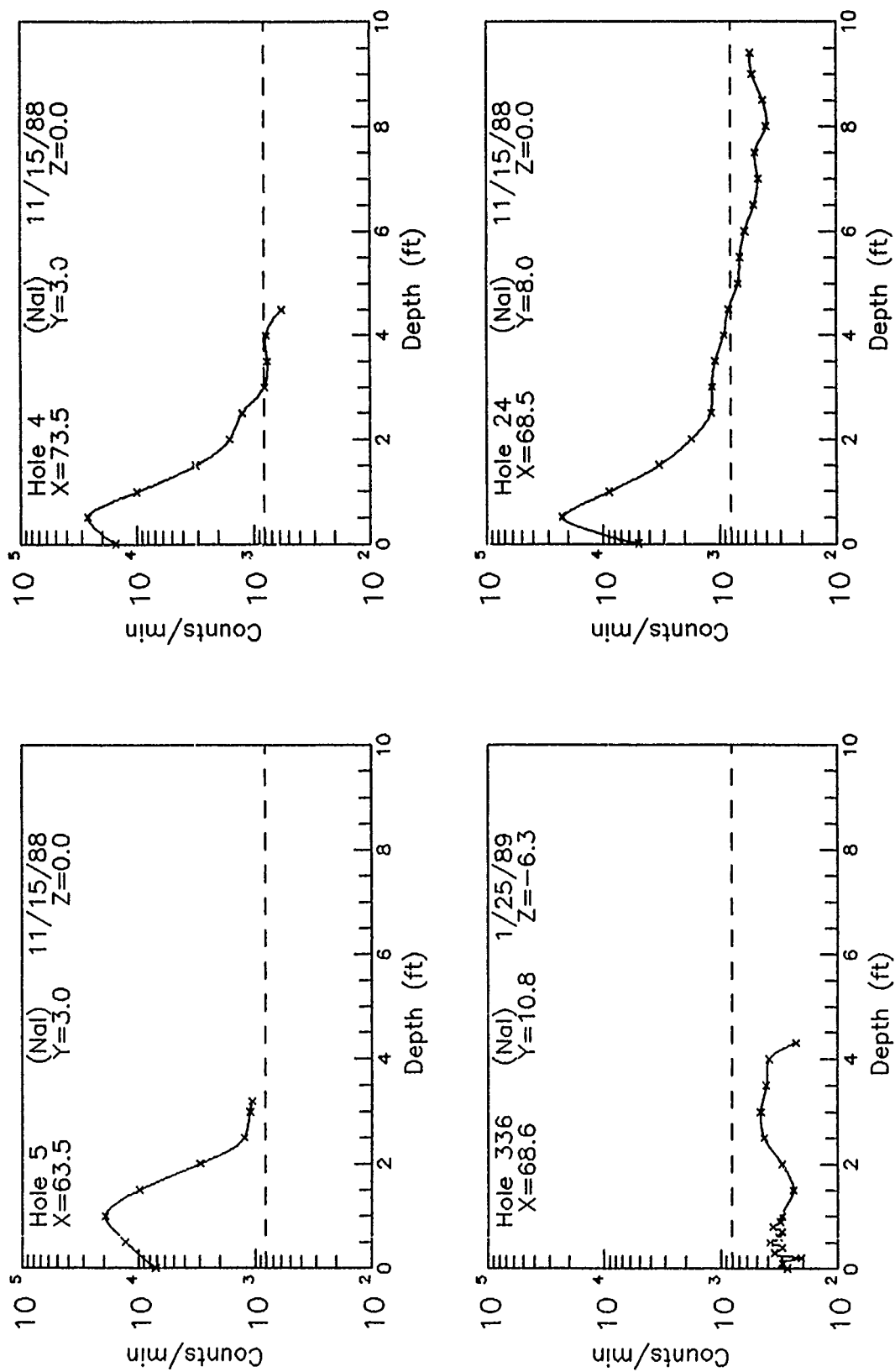


Figure C109. Subsurface Data from 105 E. Stratford in Map Region 98

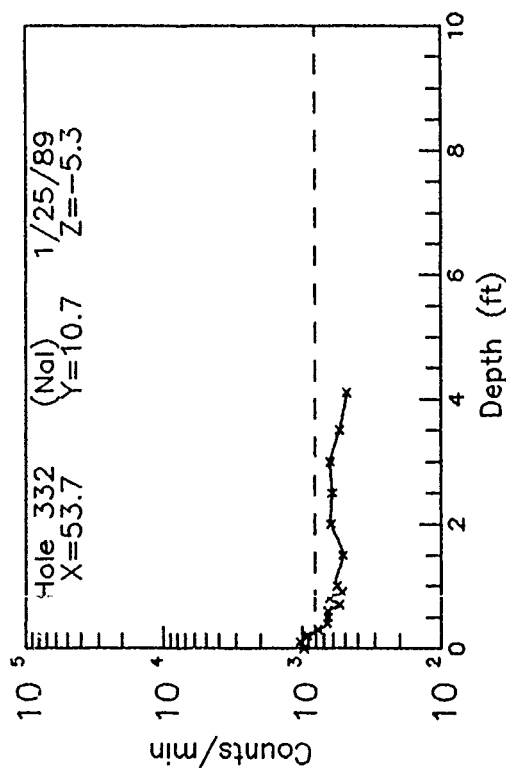
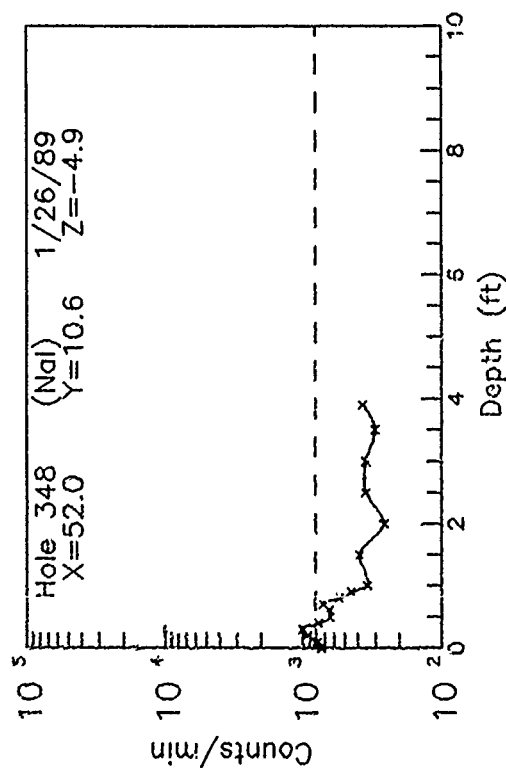
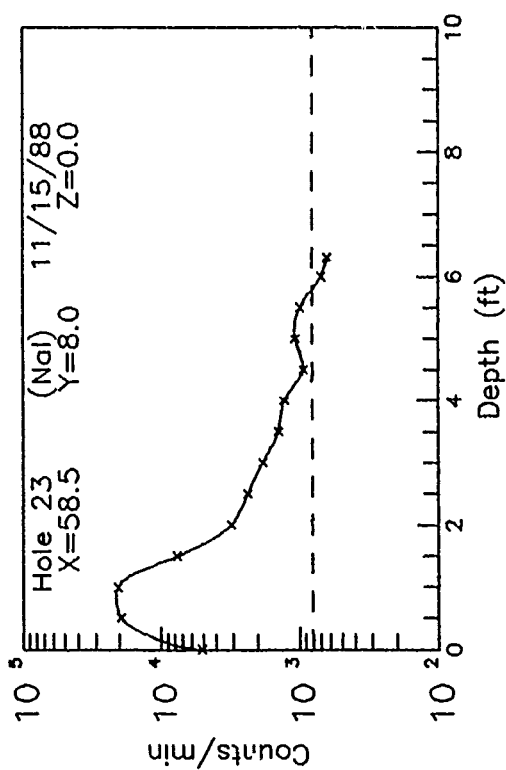
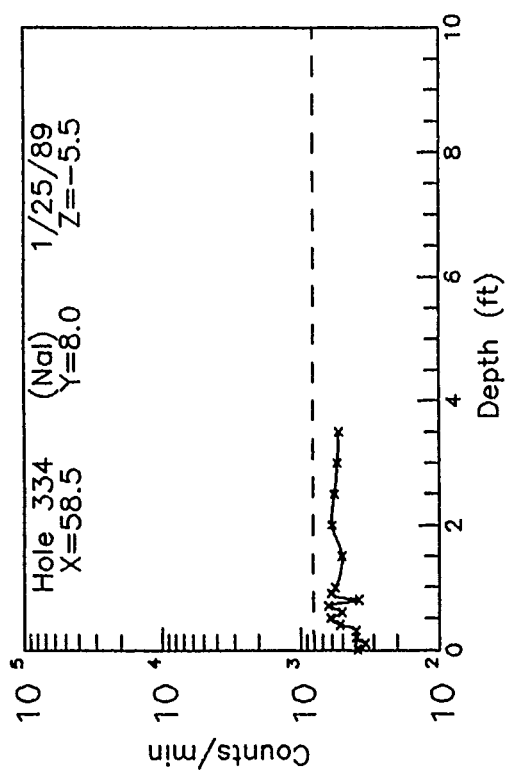


Figure C110. Subsurface Data from 105 E. Stratford in Map Region 99

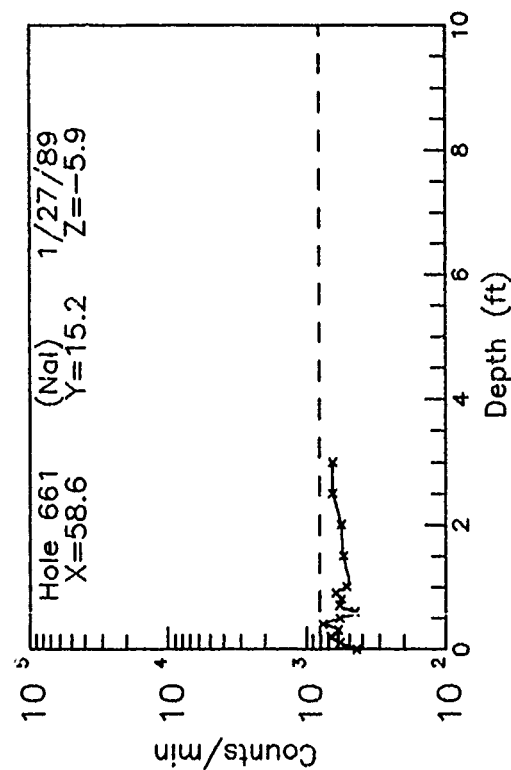
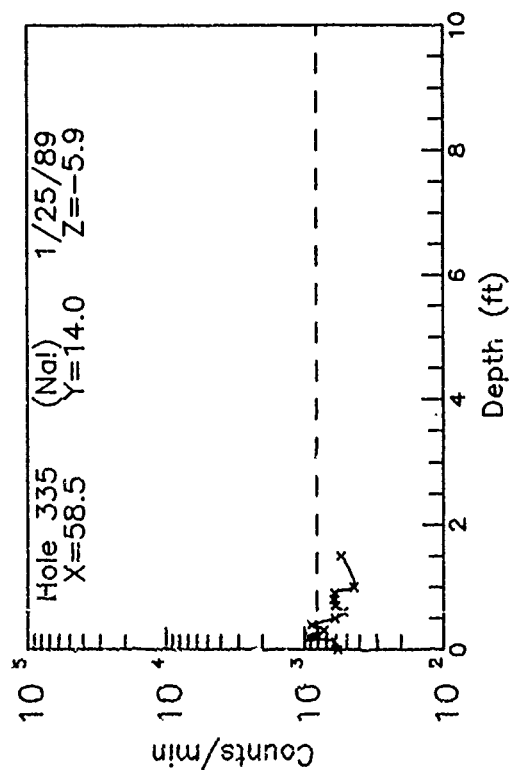
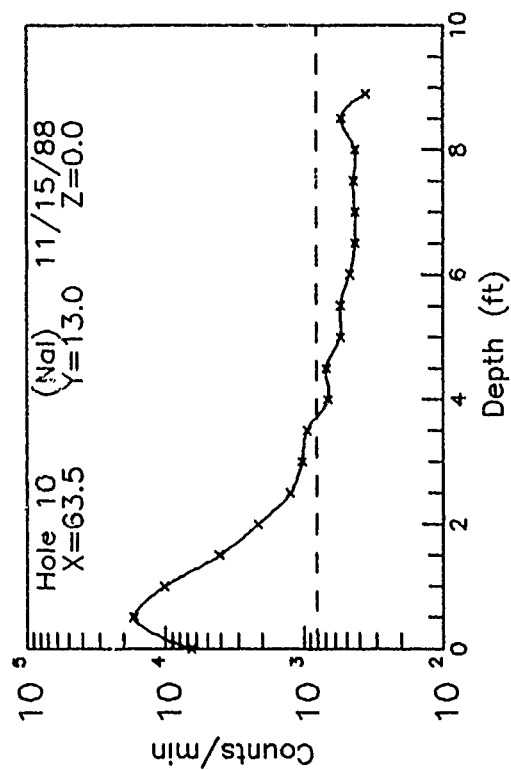
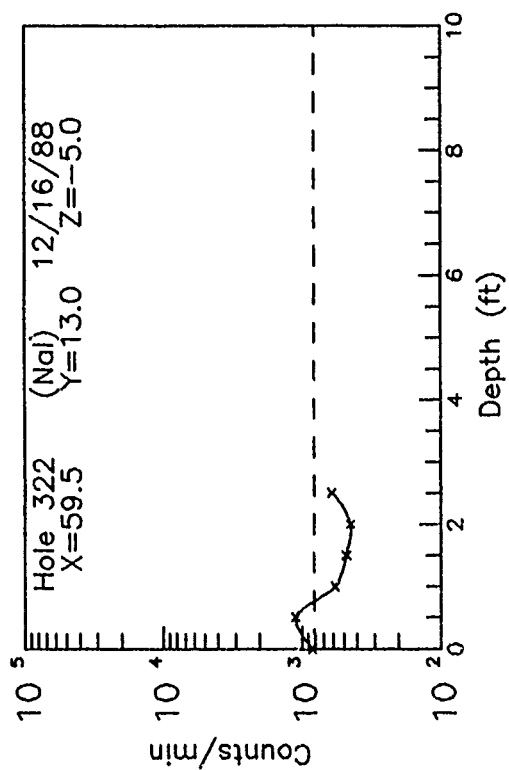


Figure C111. Subsurface Data from 105 E. Stratford in Map Region 100

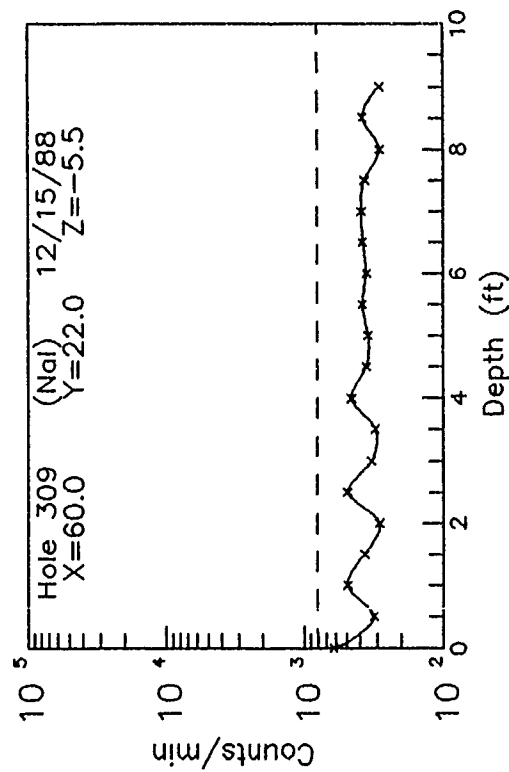
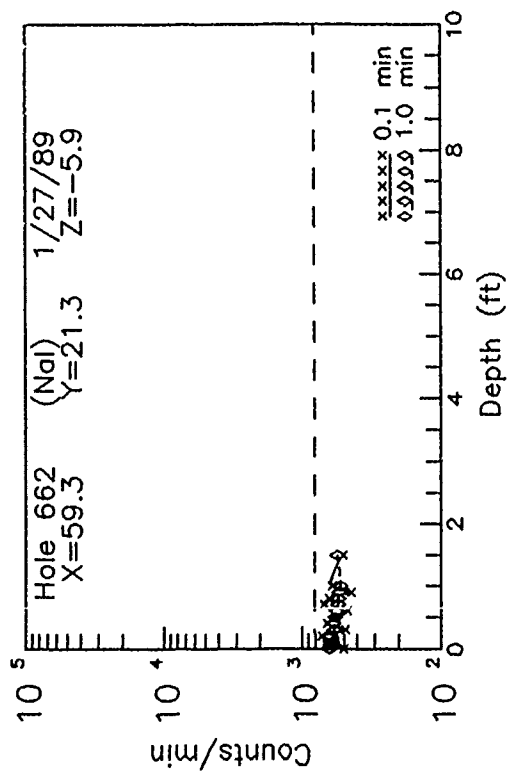
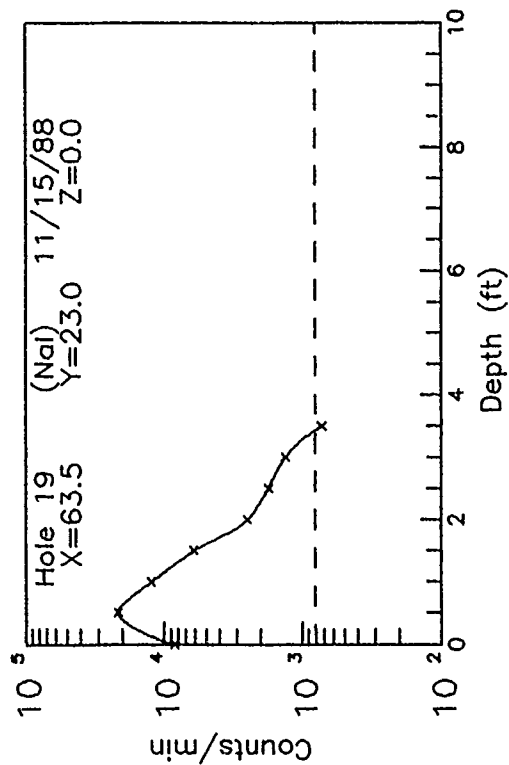
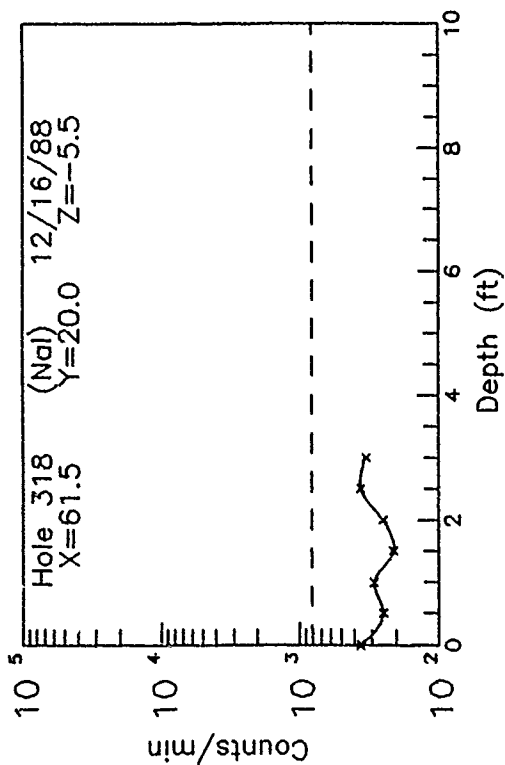


Figure C112. Subsurface Data from 105 E. Stratford in Map Region 101

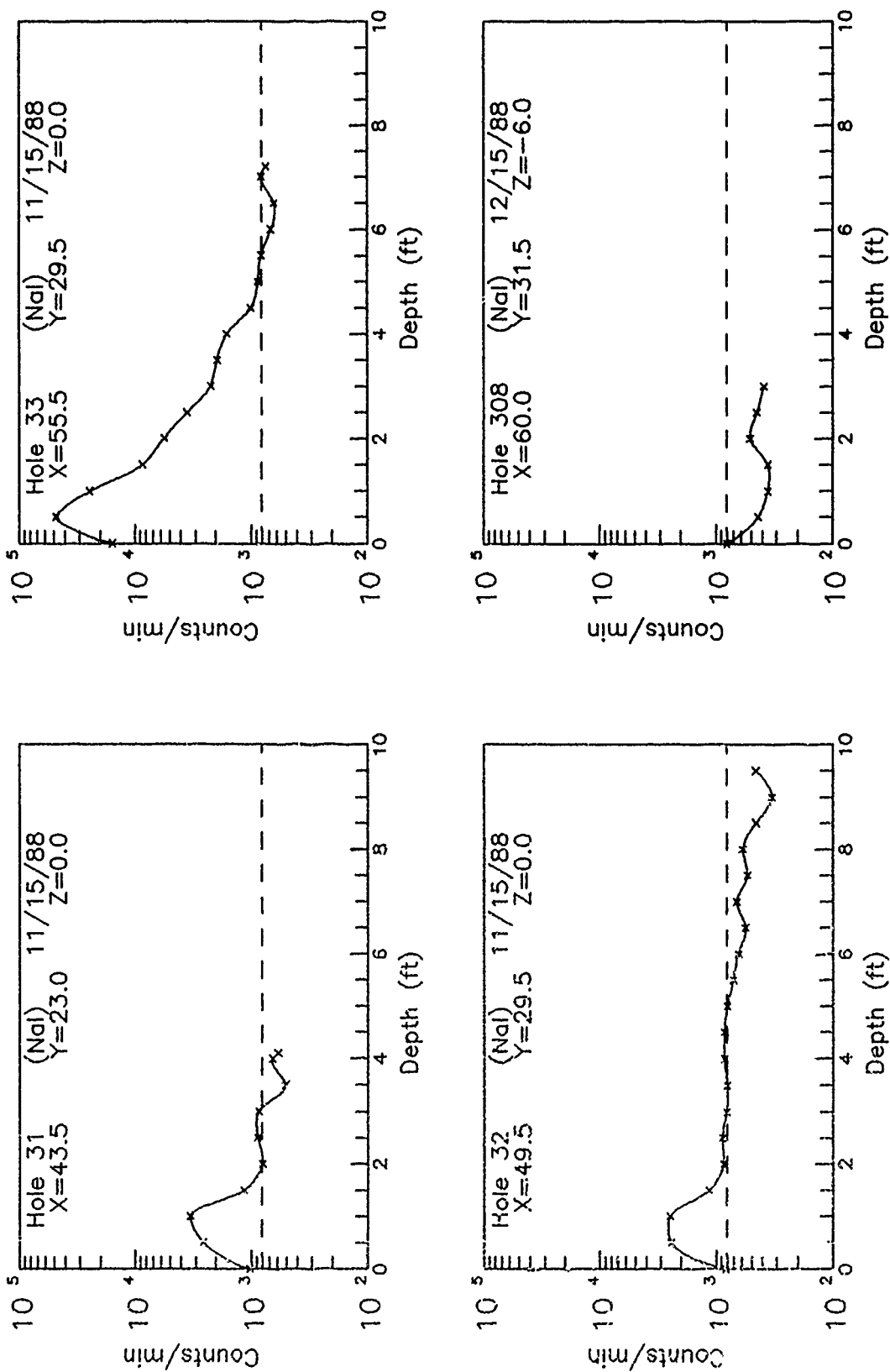


Figure C113. Subsurface Data from 105 E. Stratford in Map Region 102

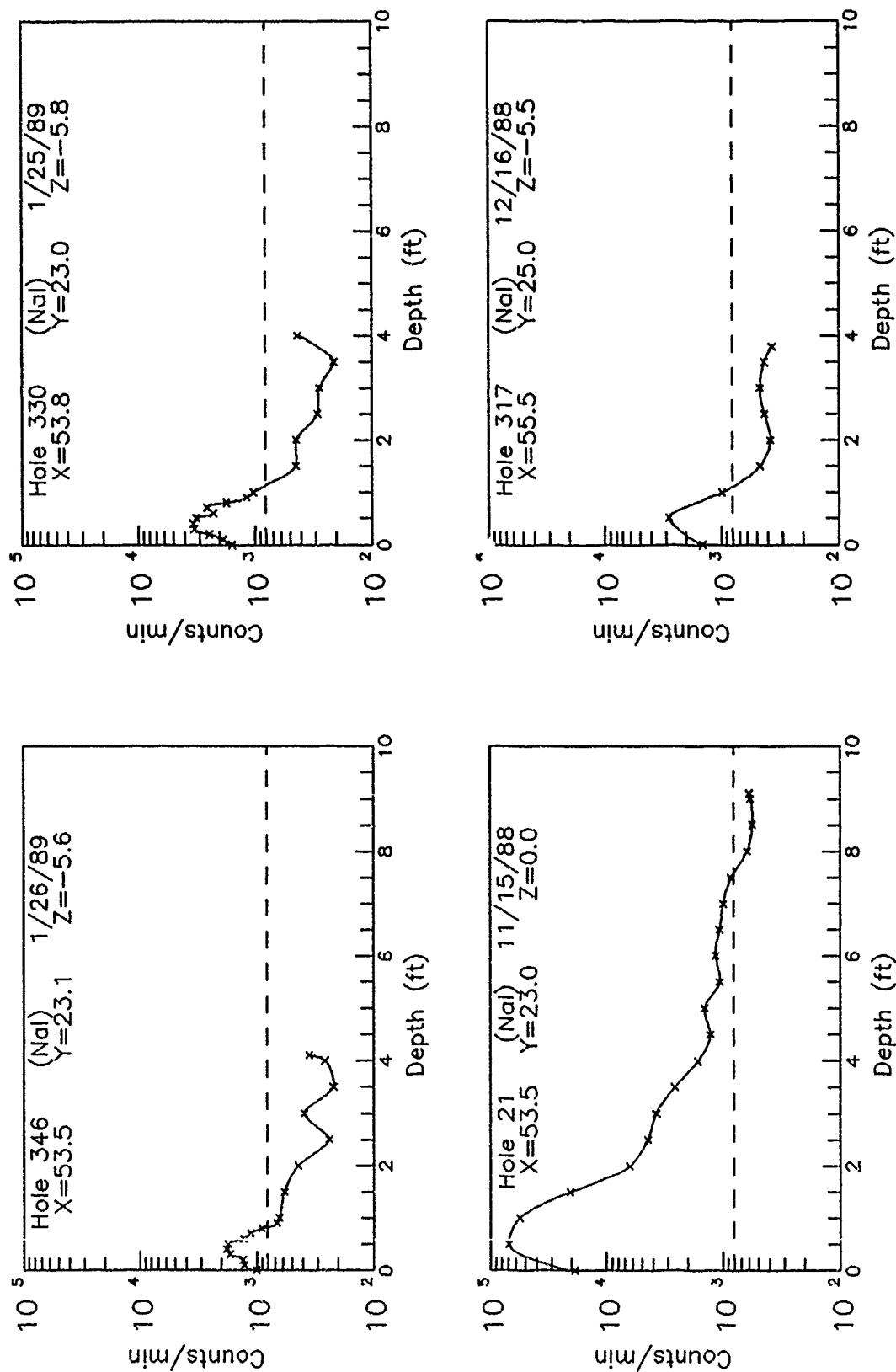


Figure C114. Subsurface Data from 105 E. Stratford in Map Region 103

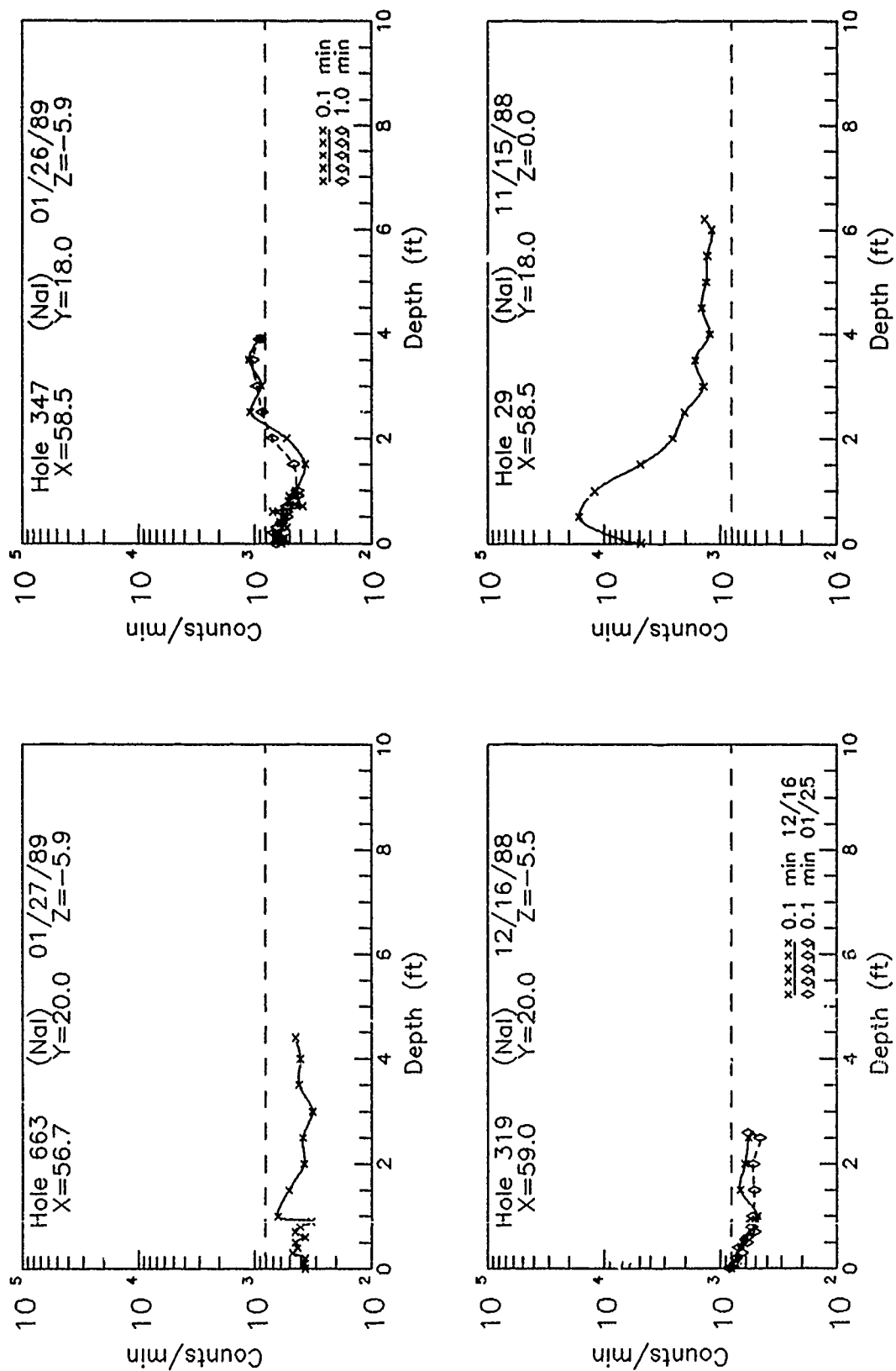


Figure C115. Subsurface Data from 105 E Stratford in Map Region 104

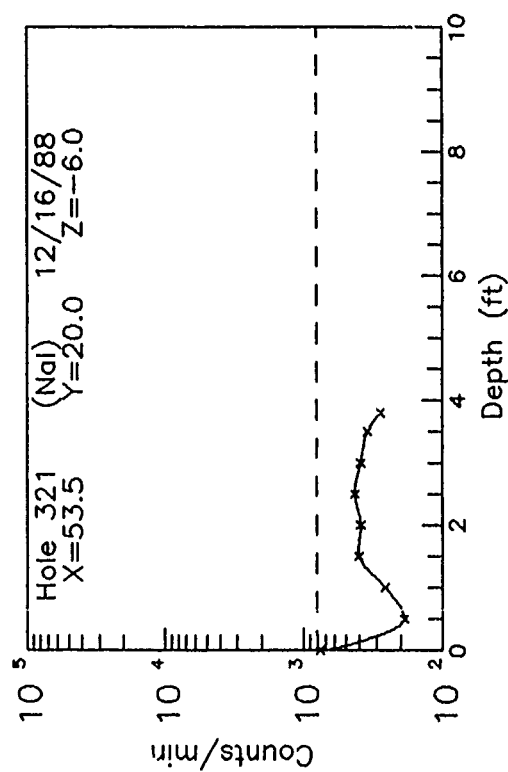
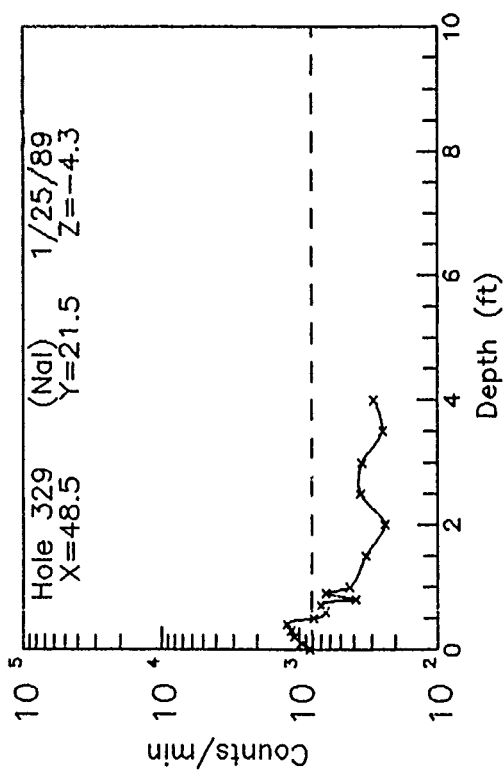
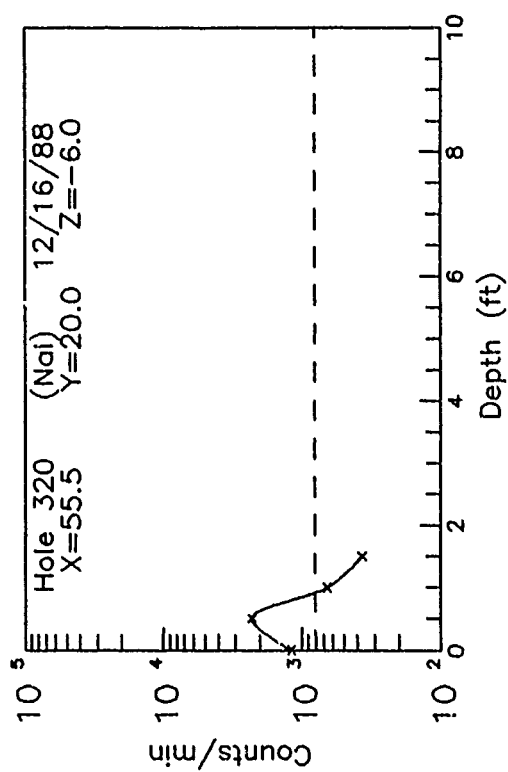
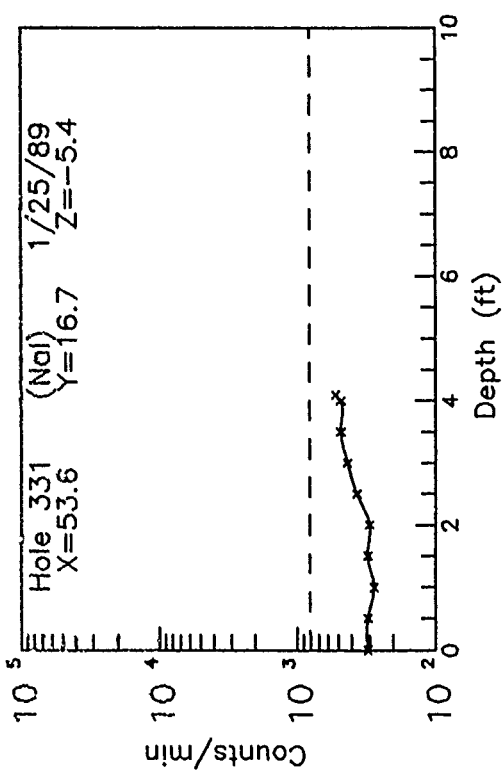


Figure C116. Subsurface Data from 105 E. Stratford in Map Region 105

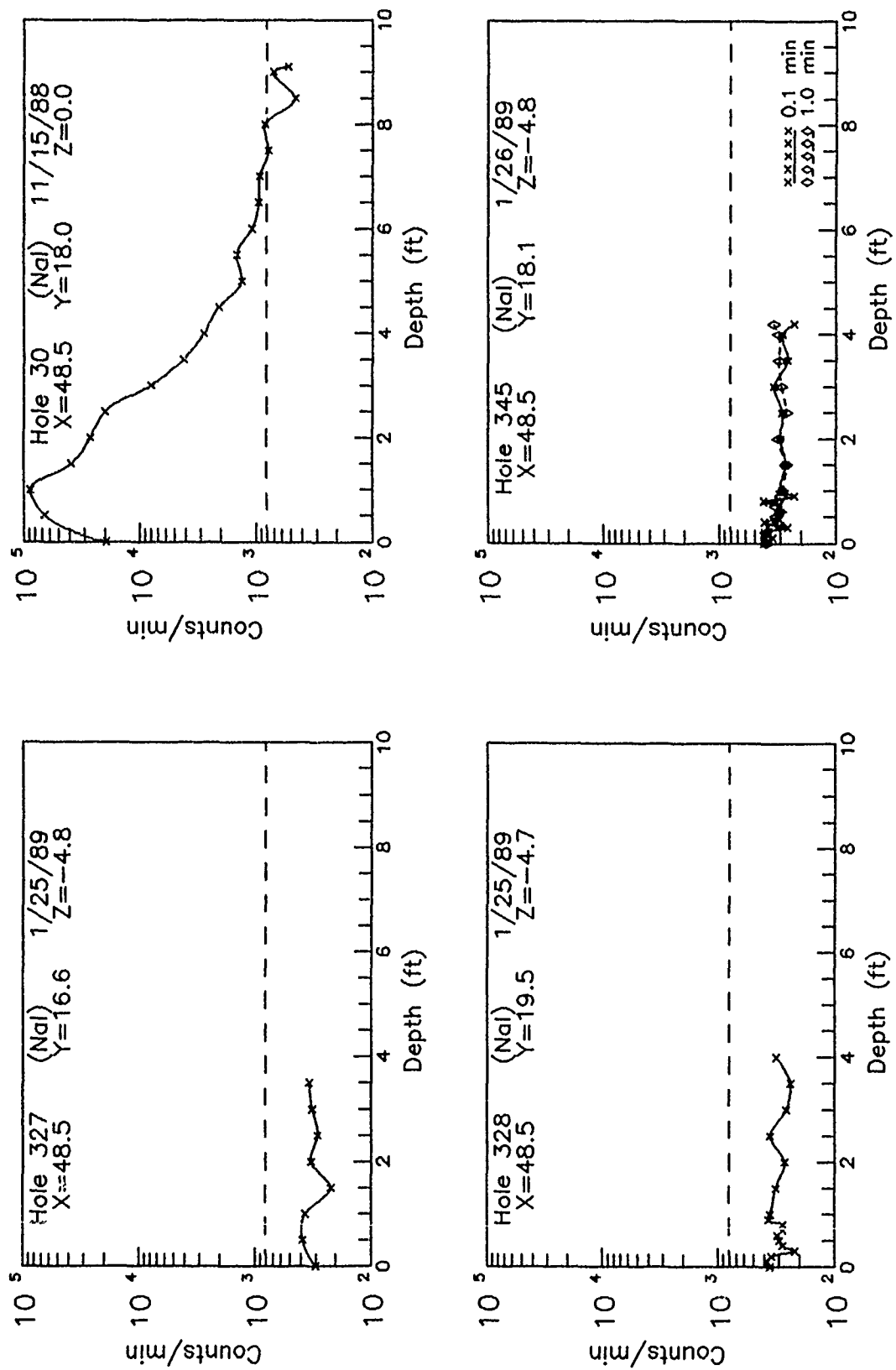


Figure C117. Subsurface Data from 105 E. Stratford in Map Region 106

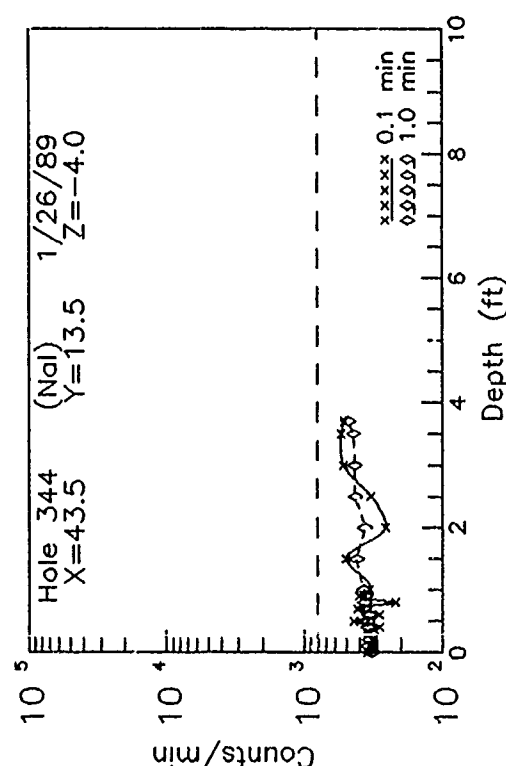
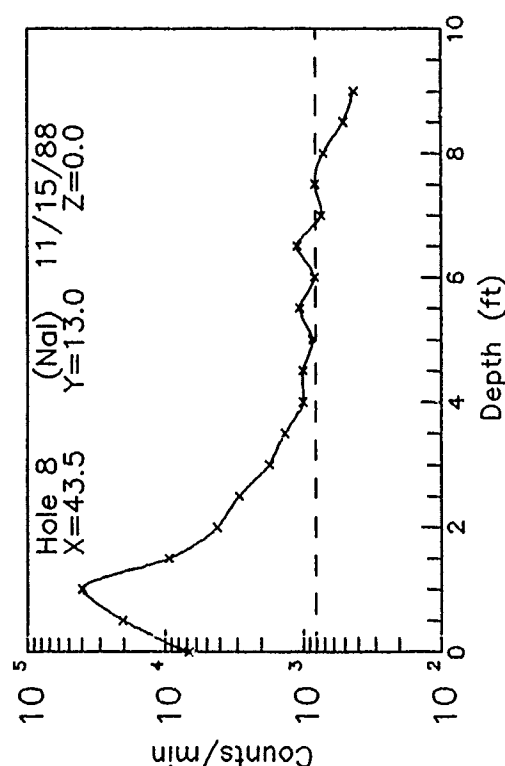
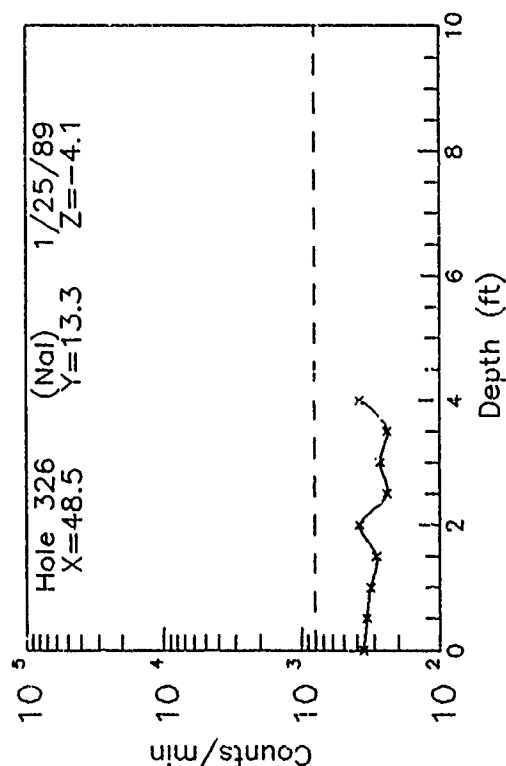
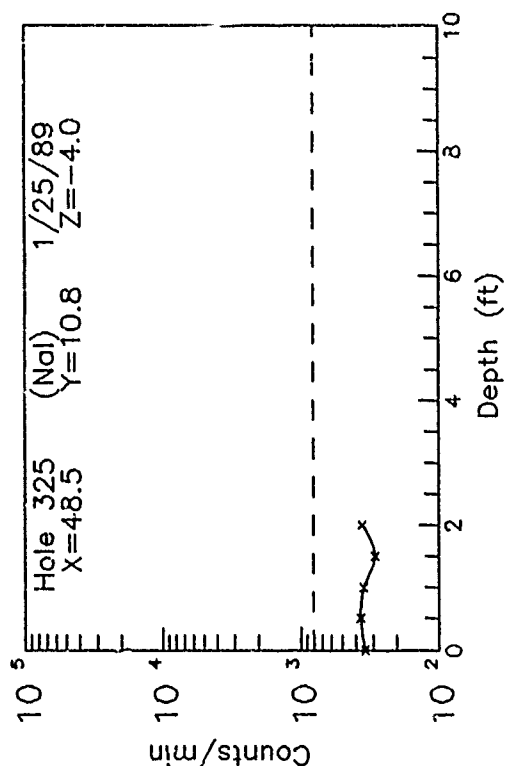


Figure C118. Subsurface Data from 105 E. Stratford in Map Region 107

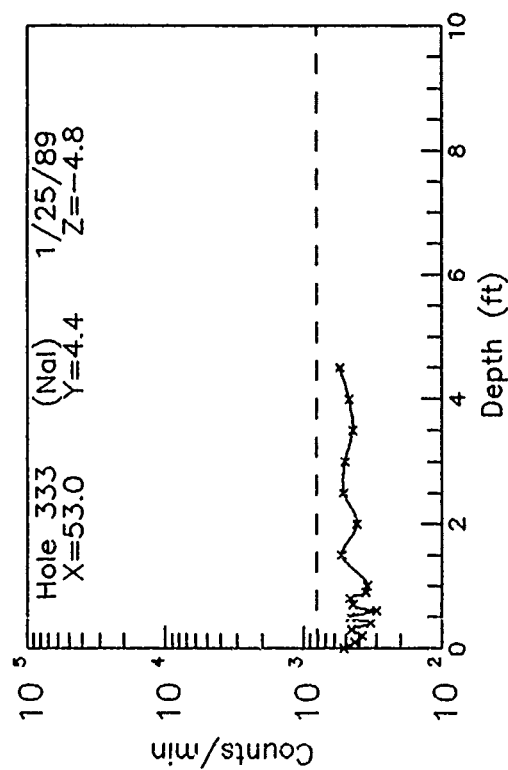
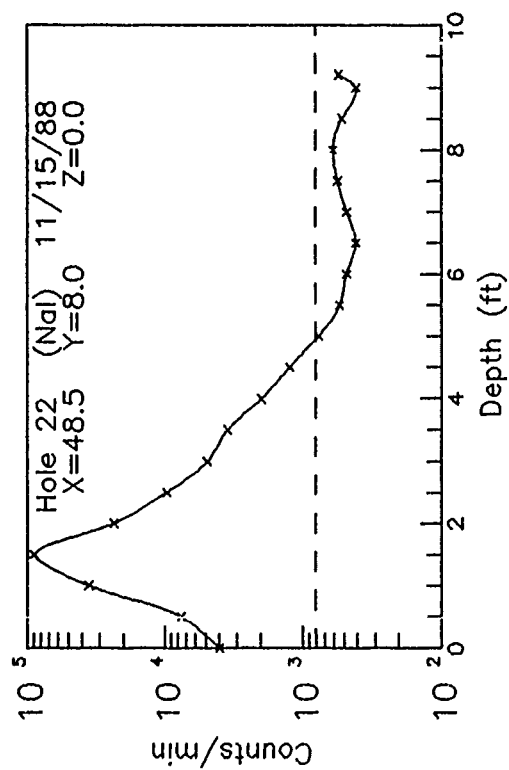
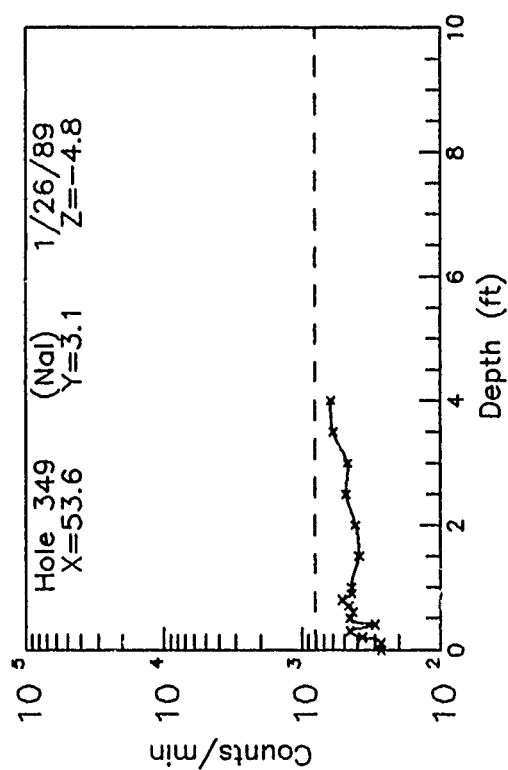
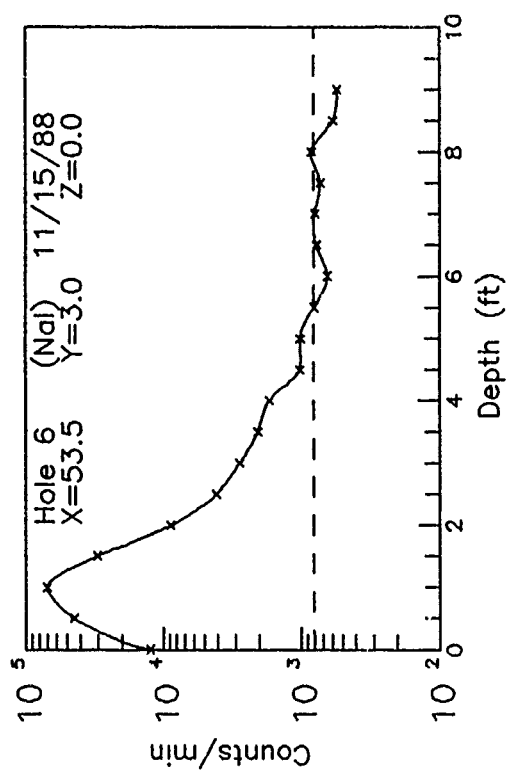


Figure C119. Subsurface Data from 105 E. Stratford in Map Region 108

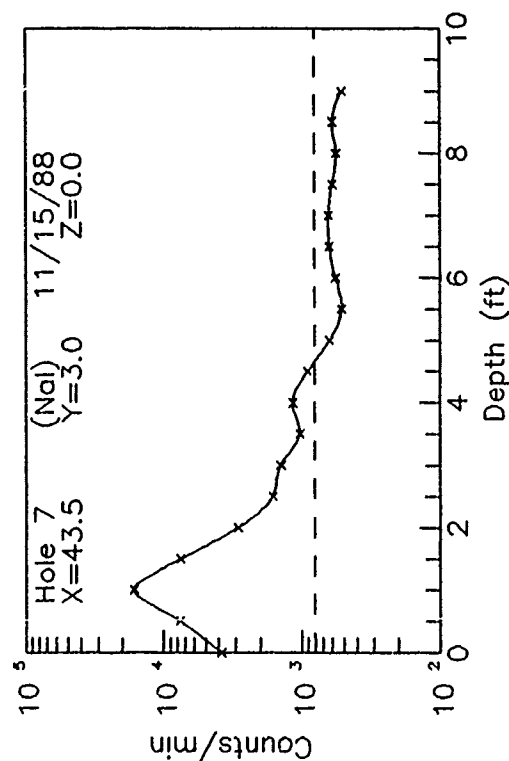
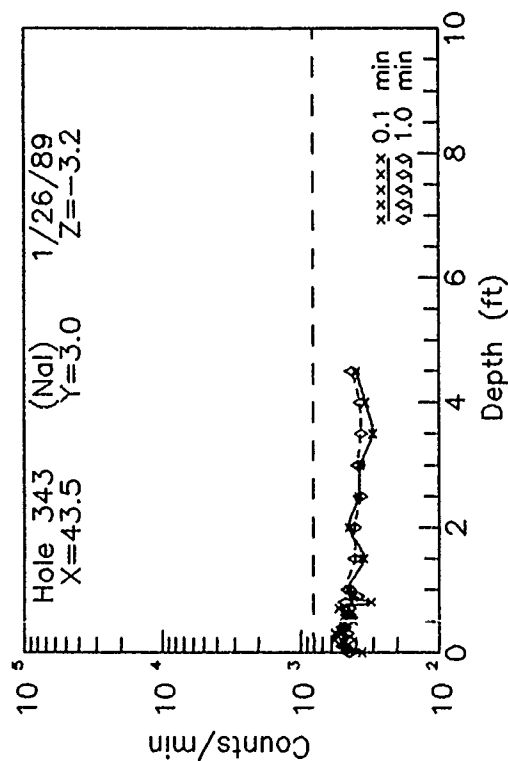
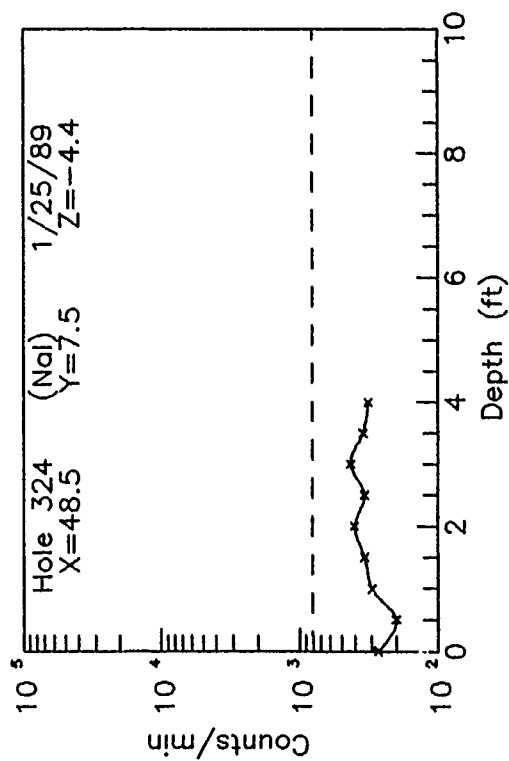
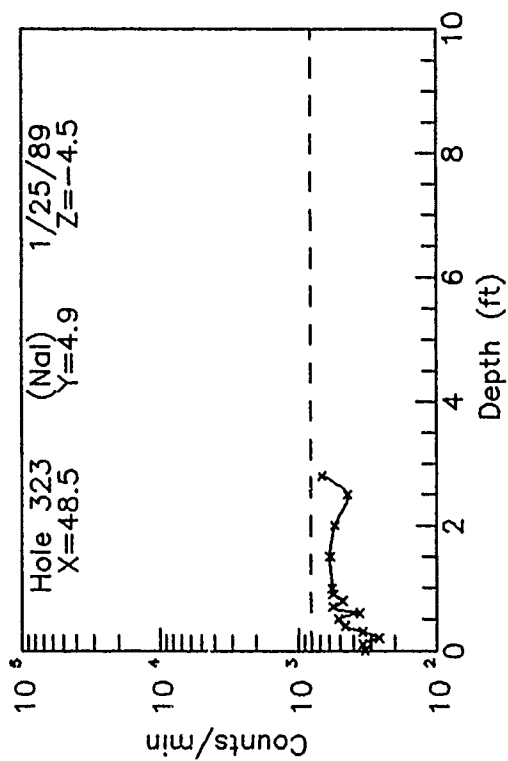


Figure C120. Subsurface Data from 105 E. Stratford in Map Region 109

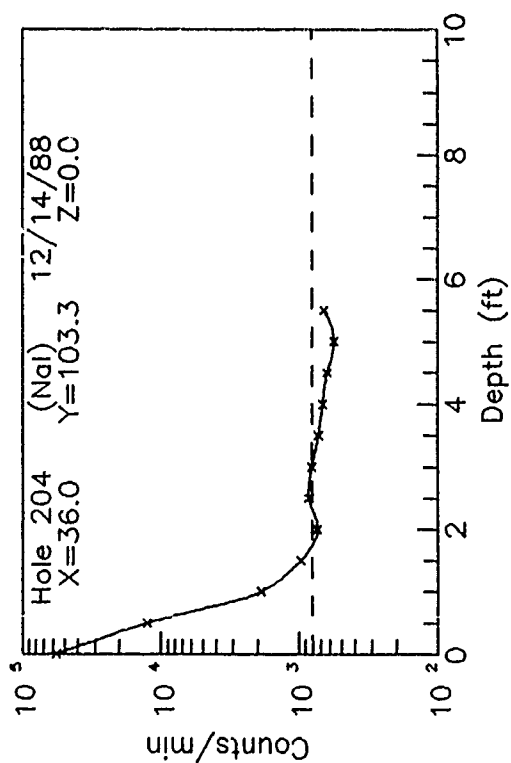
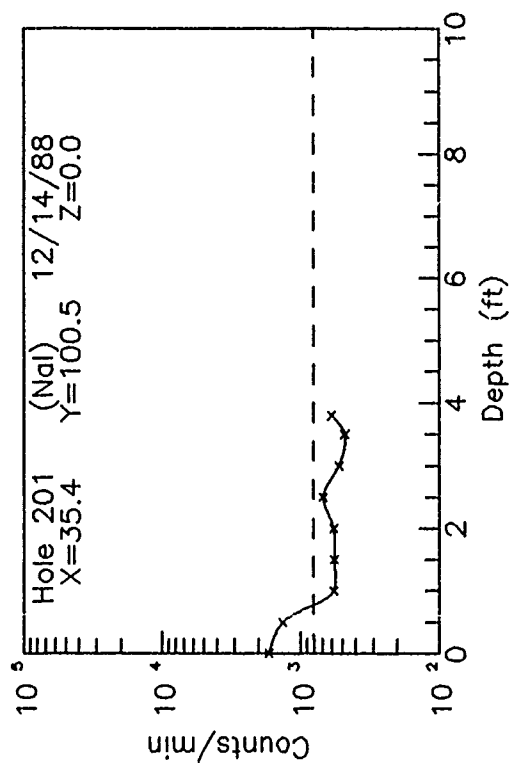
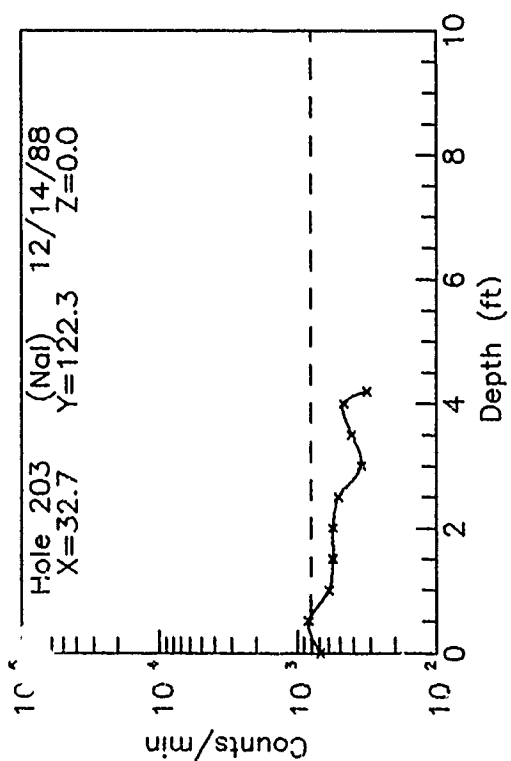
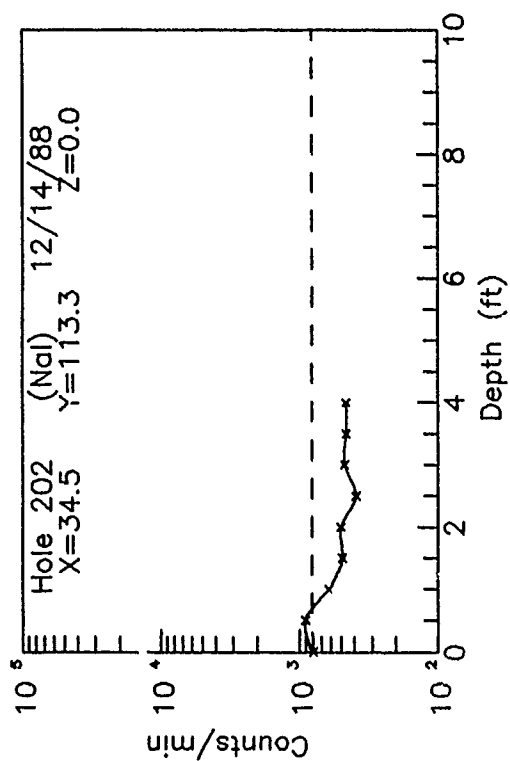


Figure C121. Subsurface Data from 105 E. Stratford in Map Region 110

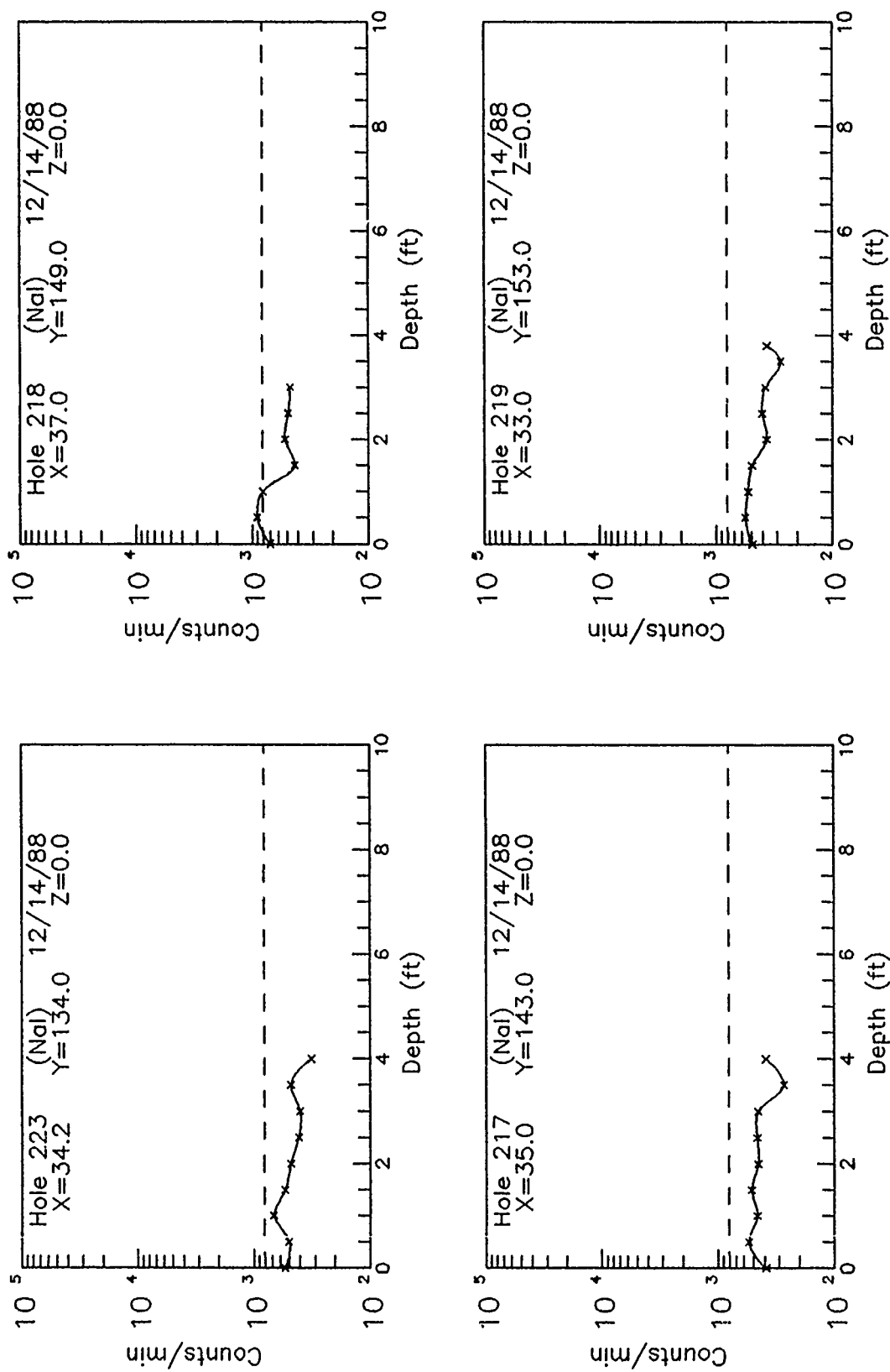


Figure C122. Subsurface Data from 105 E. Stratford in Map Region 111

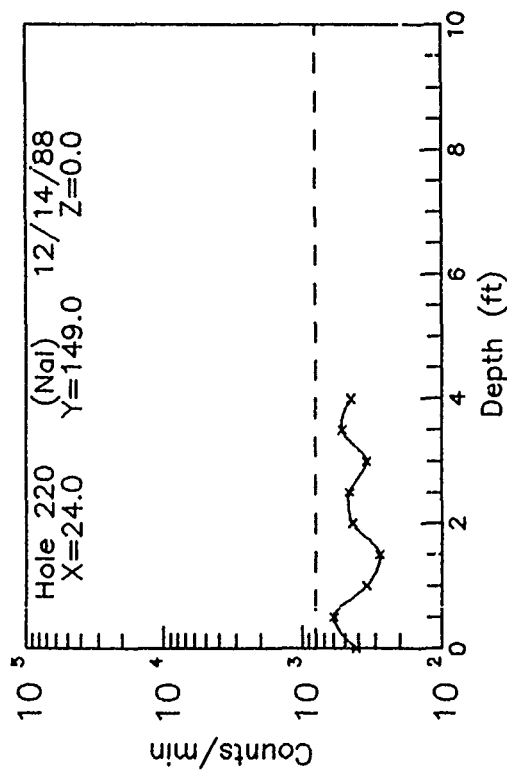
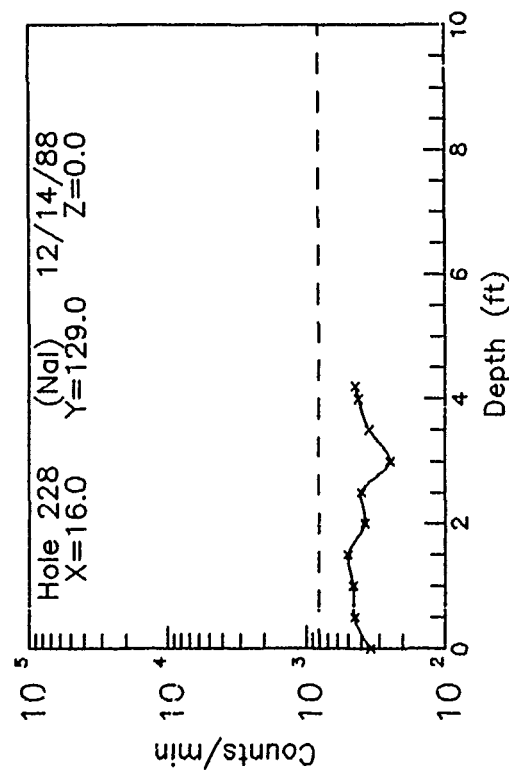
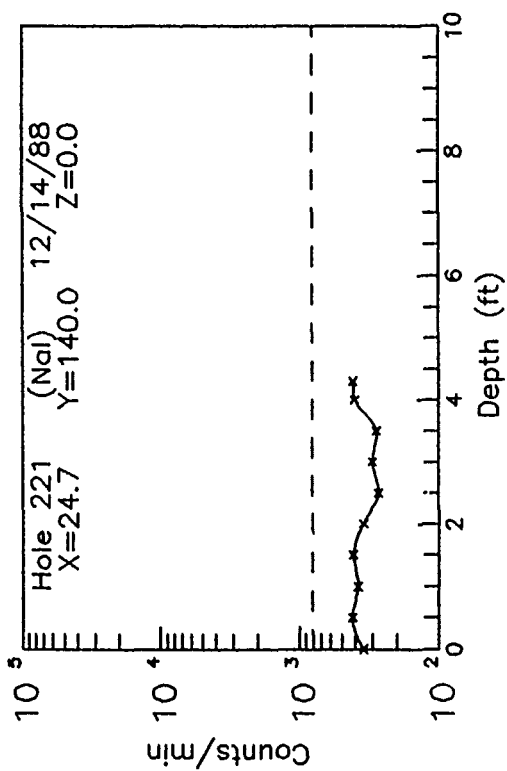
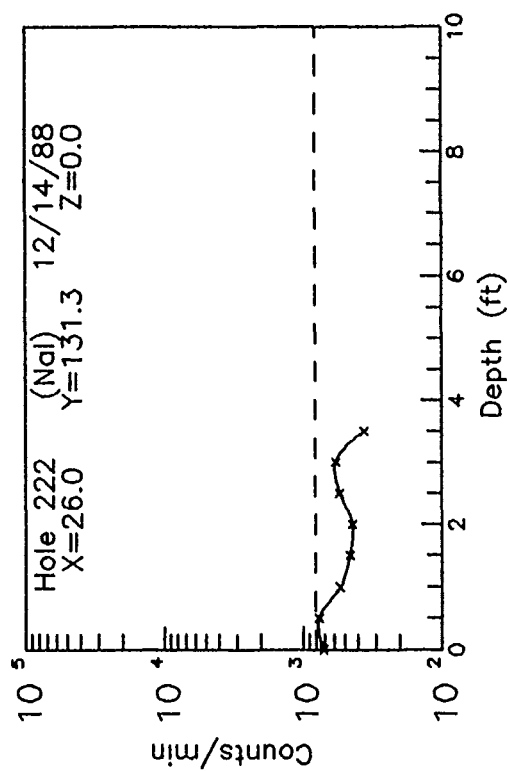


Figure C123. Subsurface Data from 105 E. Stratford in Map Region 112

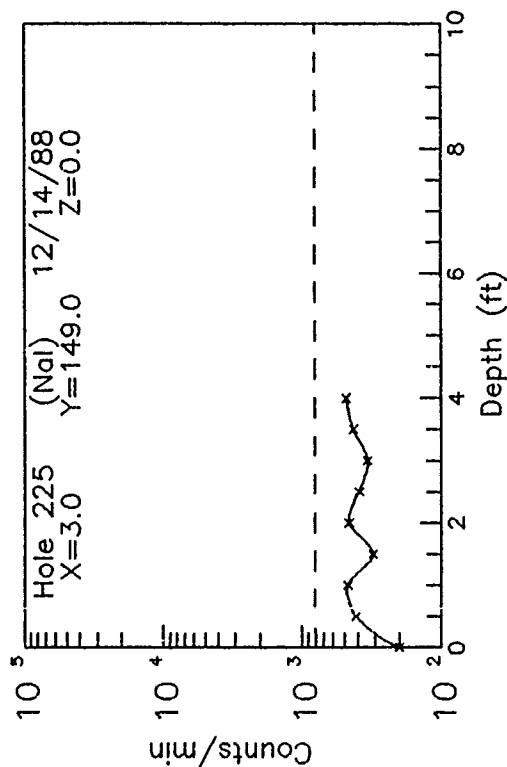
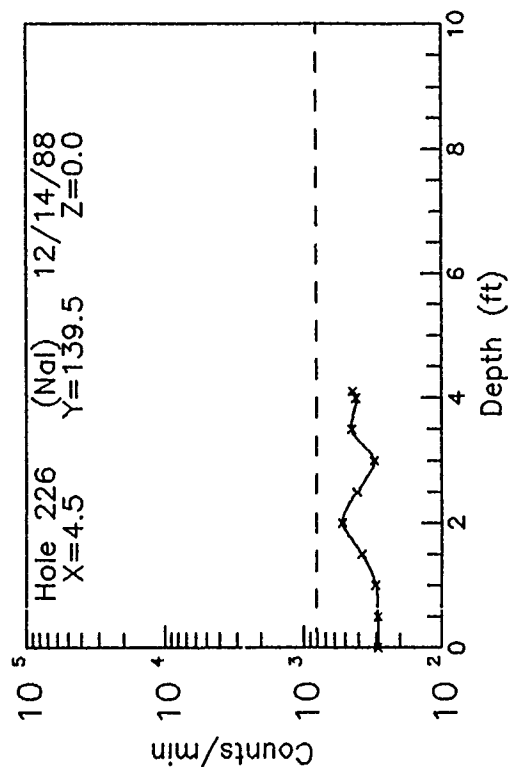
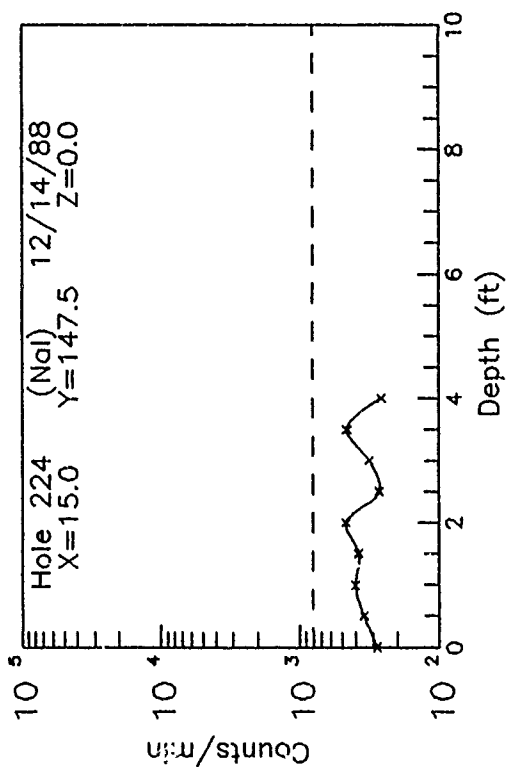
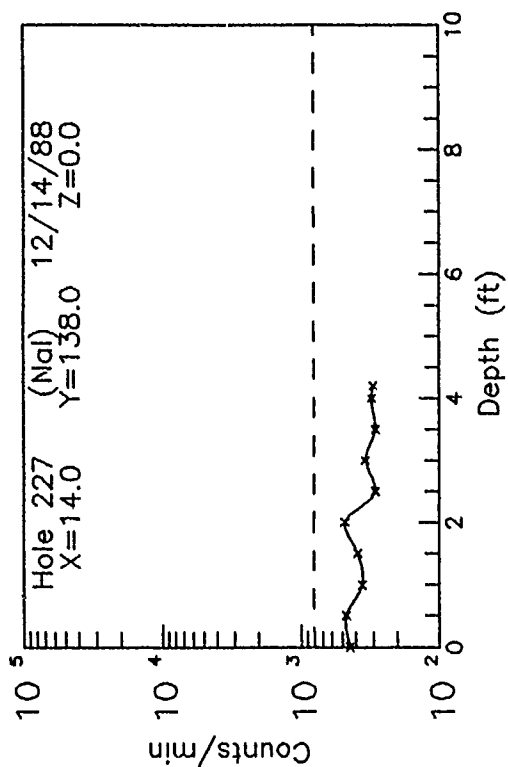


Figure C124. Subsurface Data from 105 E. Stratford in Map Region 113

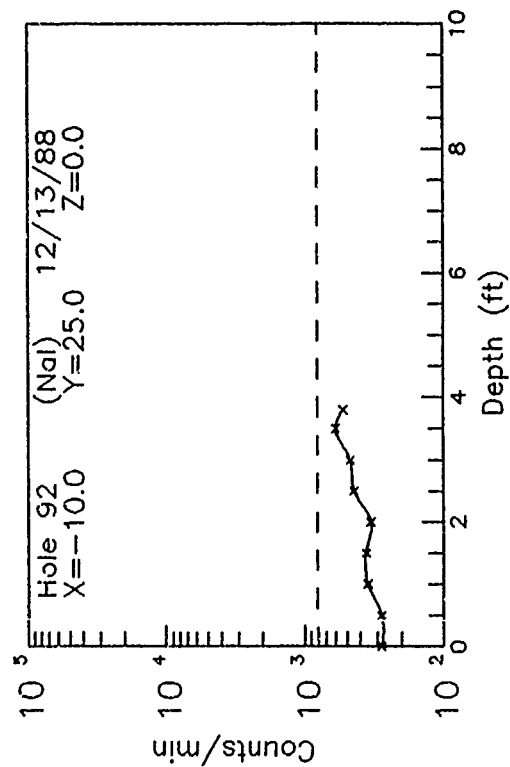
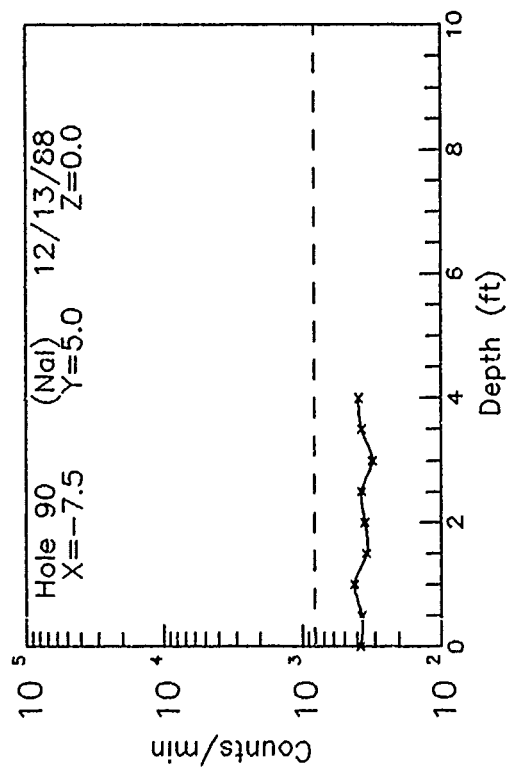
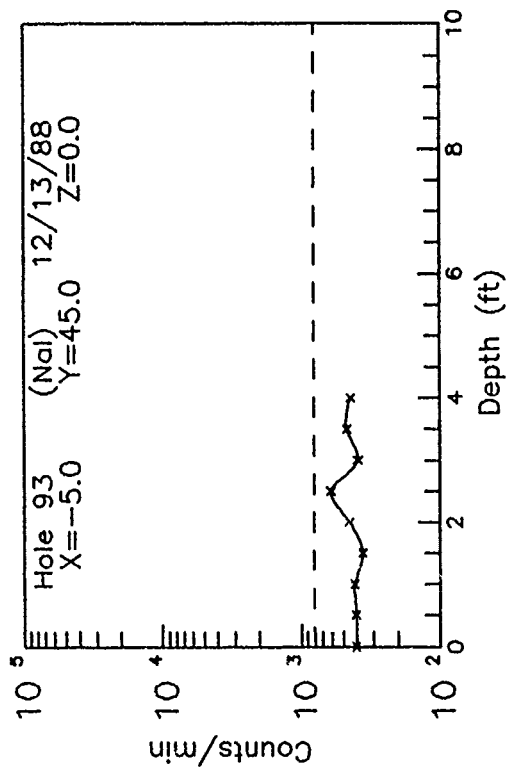
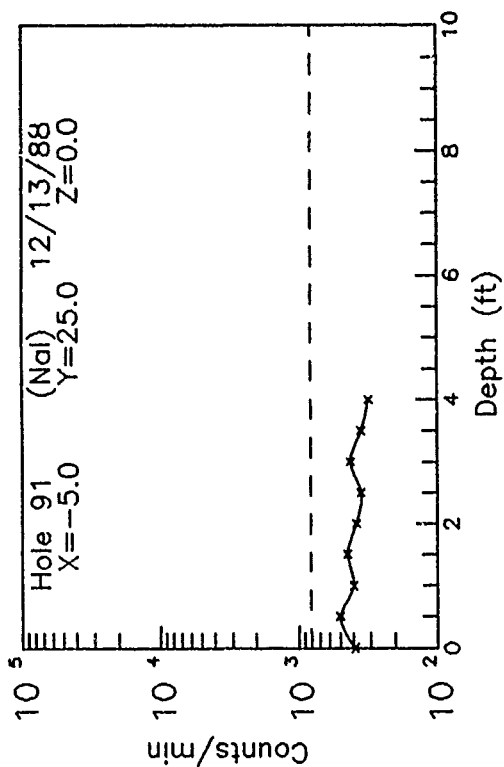


Figure C125. Subsurface Data from 99 E. Stratford in Map Region 114

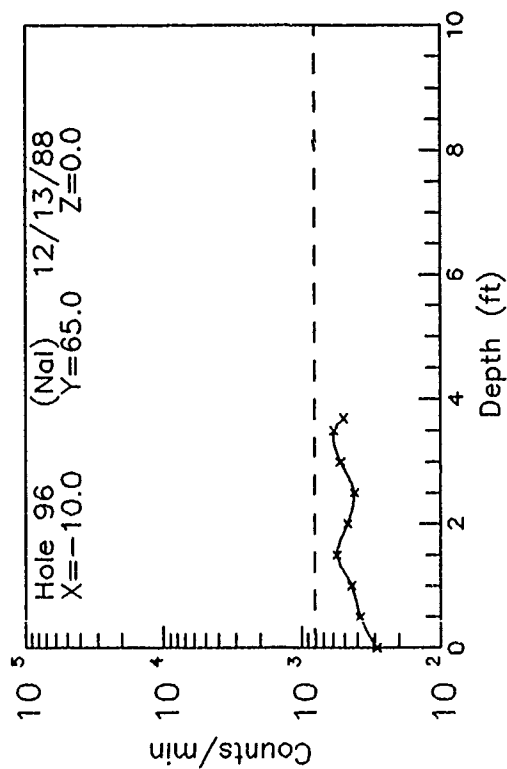
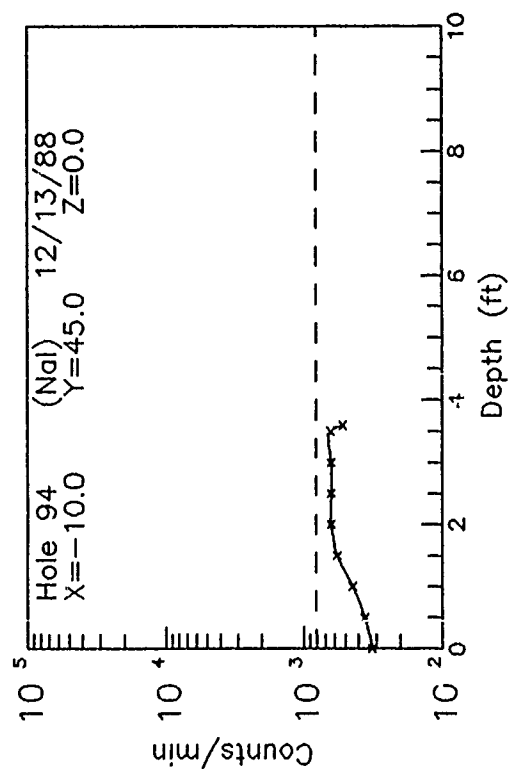
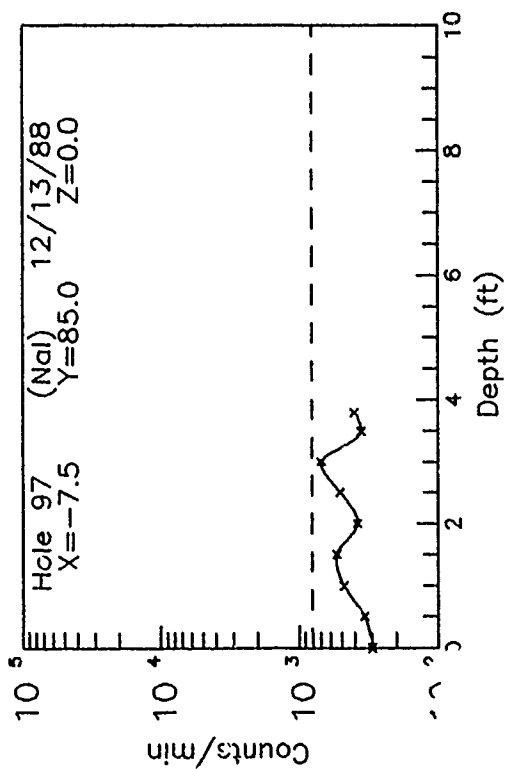
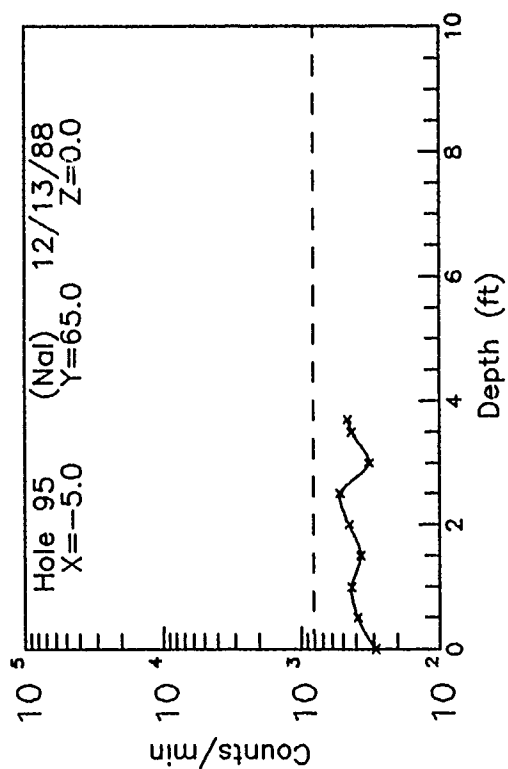


Figure C126. Subsurface Data from 99 E. Stratford in Map Region 115

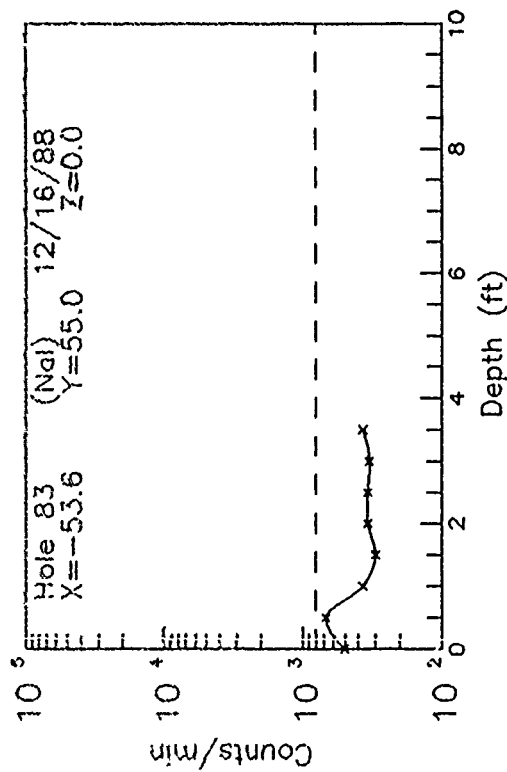
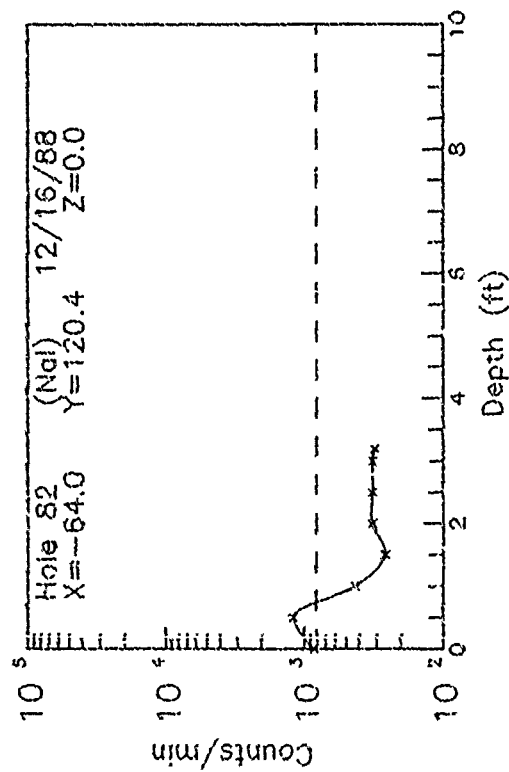
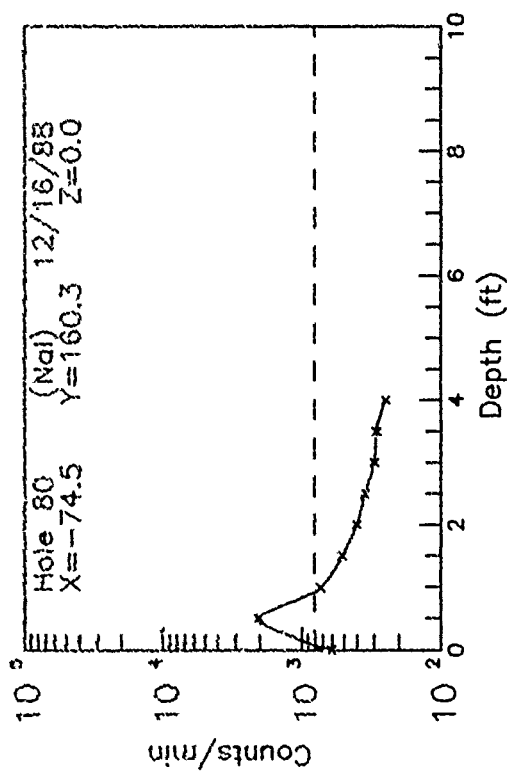
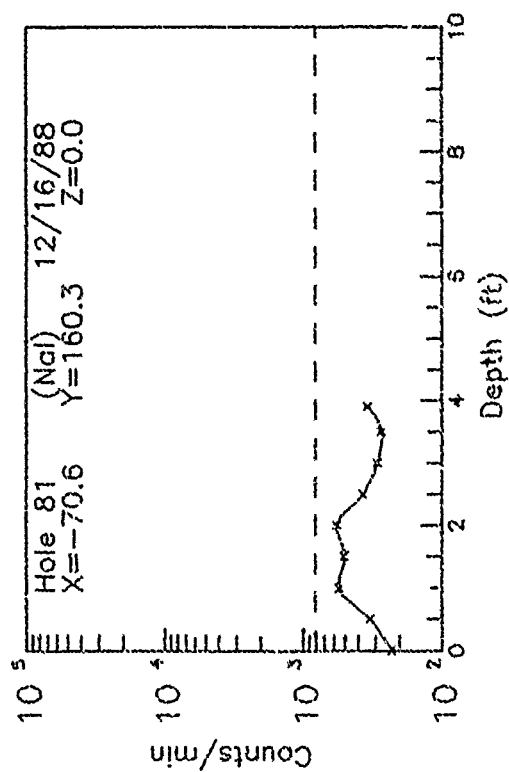


Figure C127. Subsurface Data from 99. E Stratford in Map Region 116

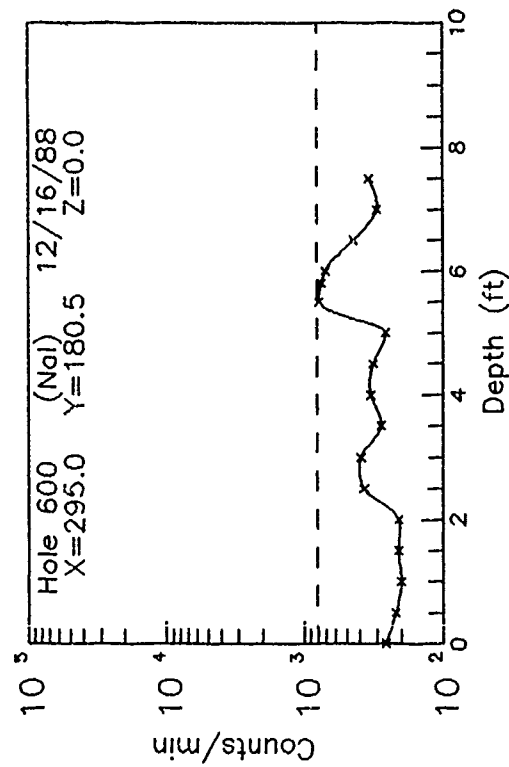
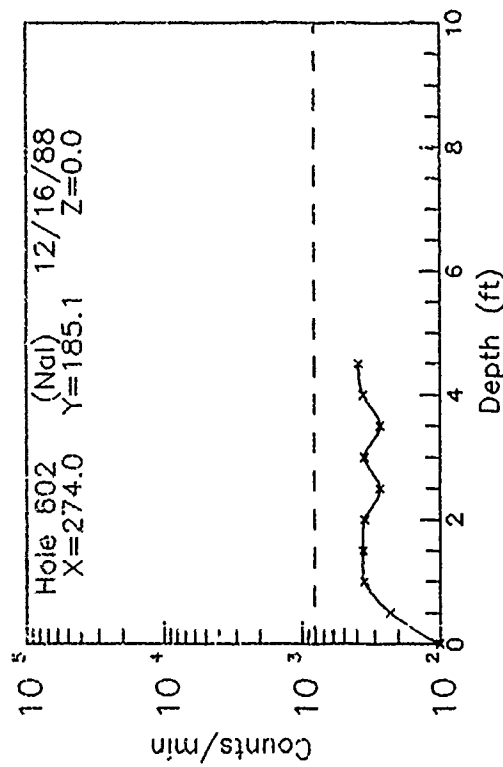
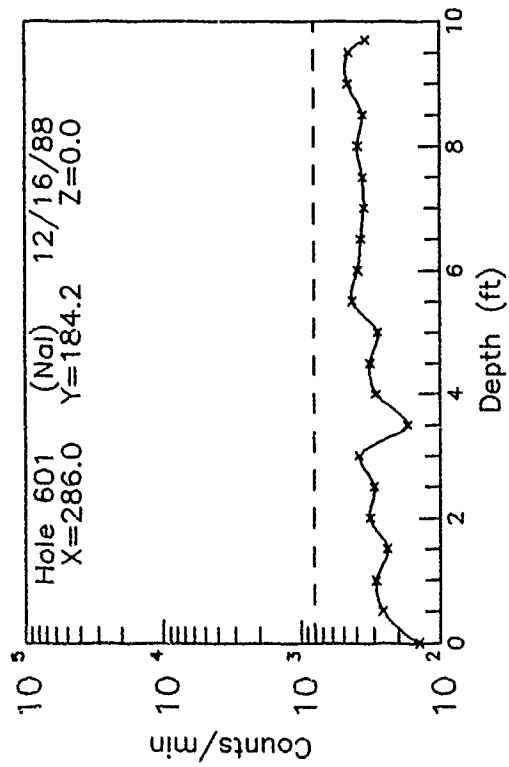
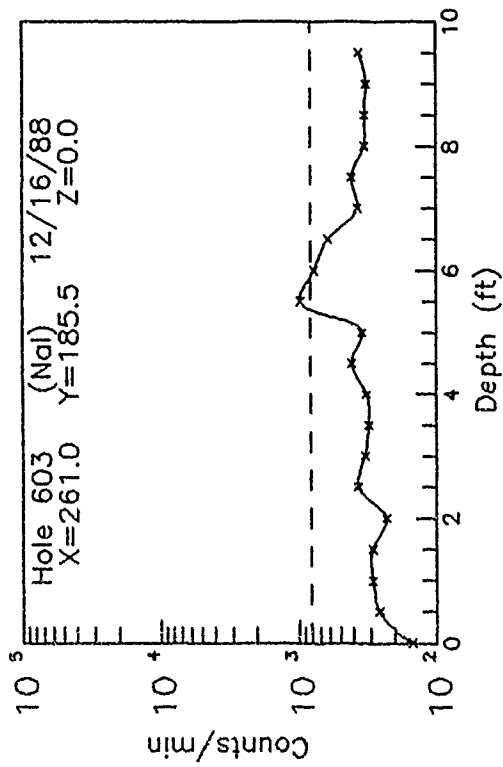


Figure C128. Subsurface Data from Stratford Sewer in Map Region 118

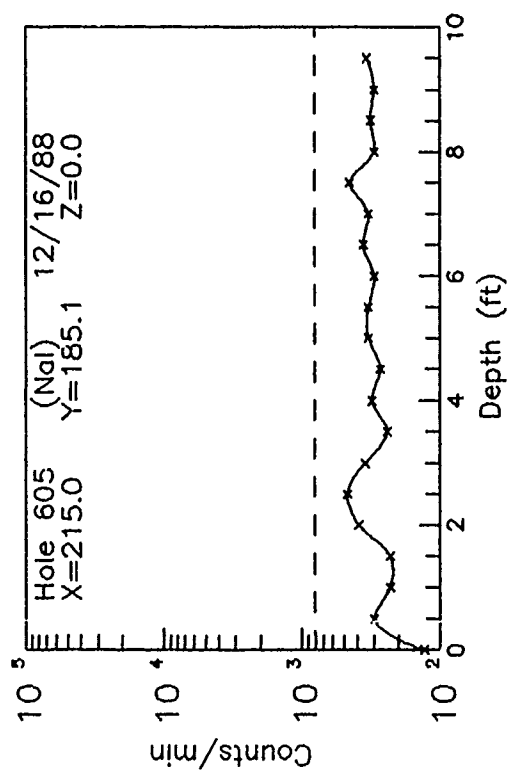
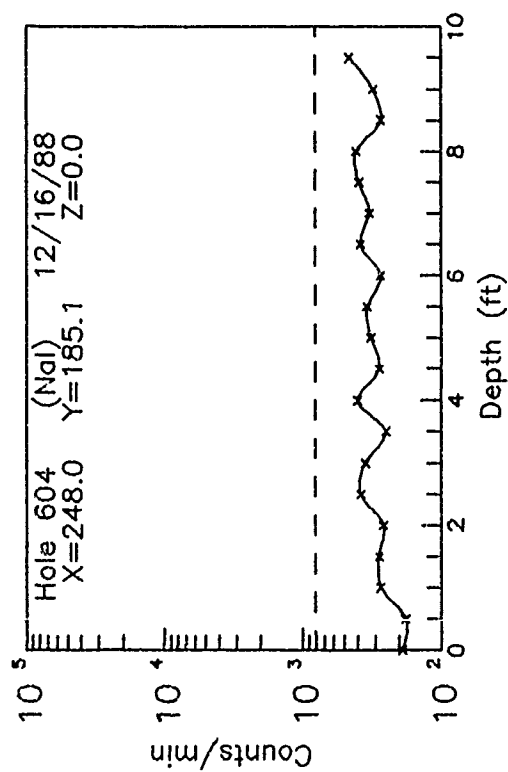
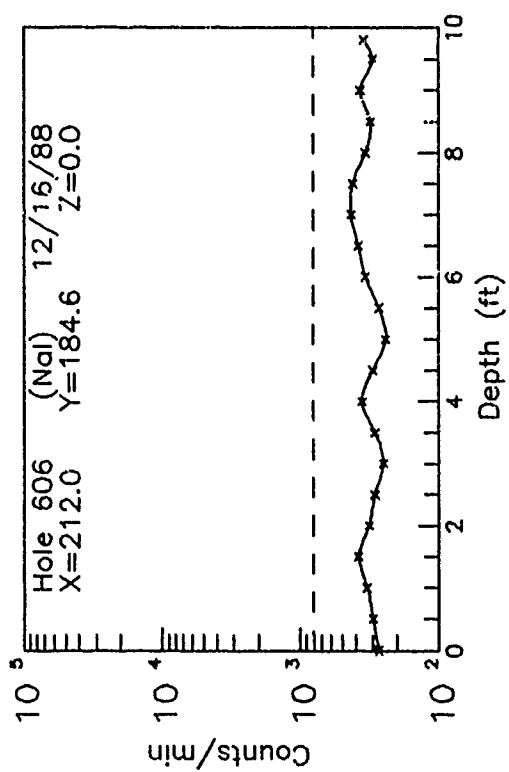
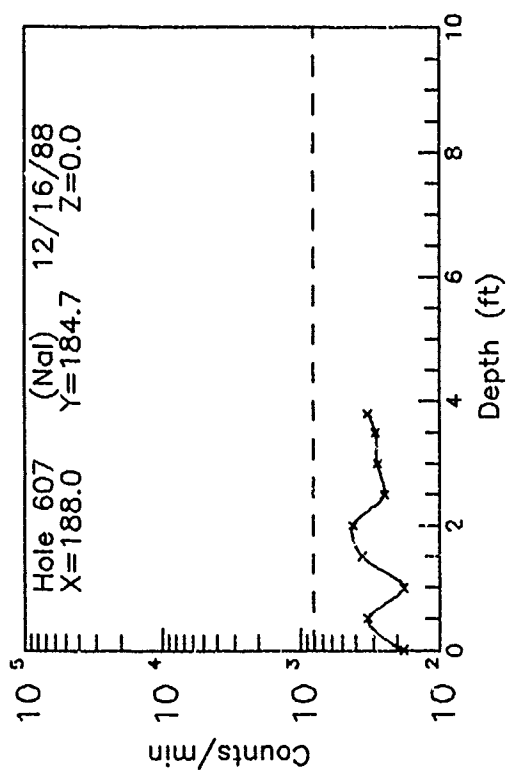


Figure C129. Subsurface Data from Stratford Sewer in Map Region 119

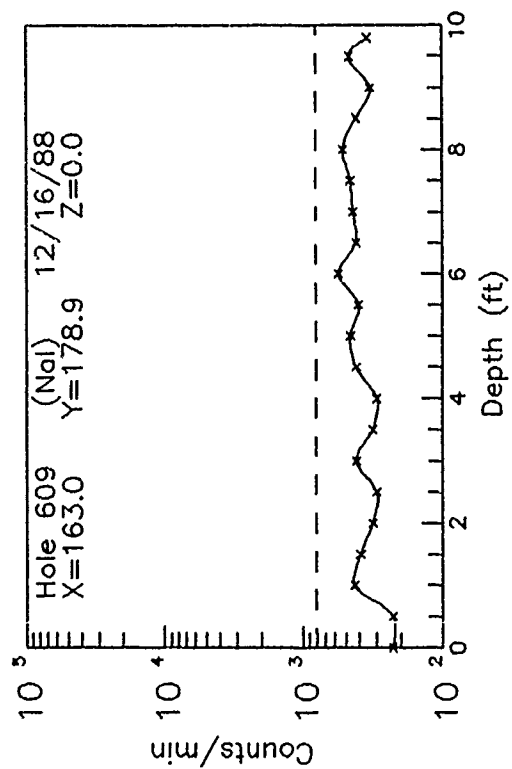
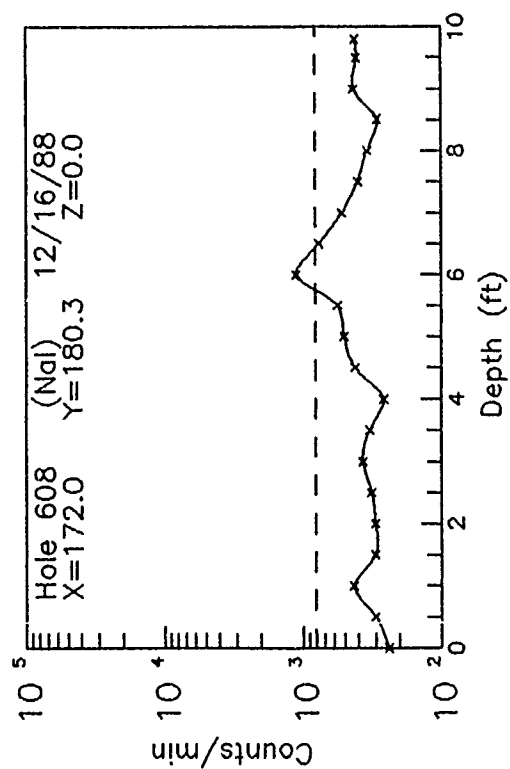
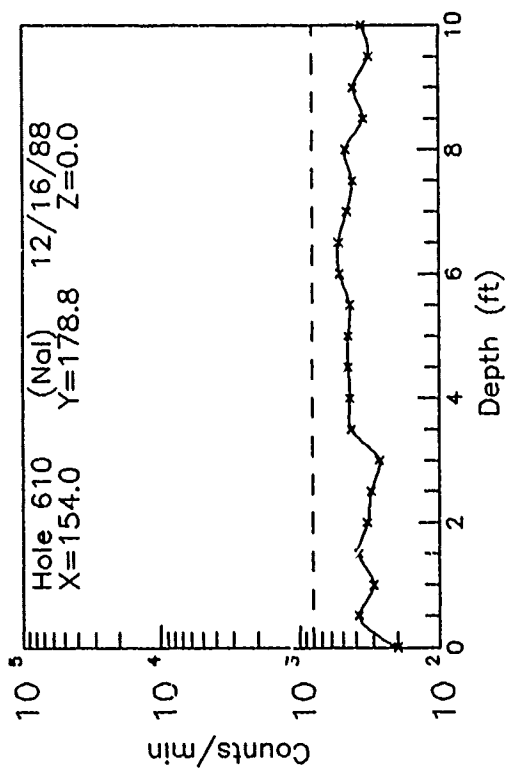
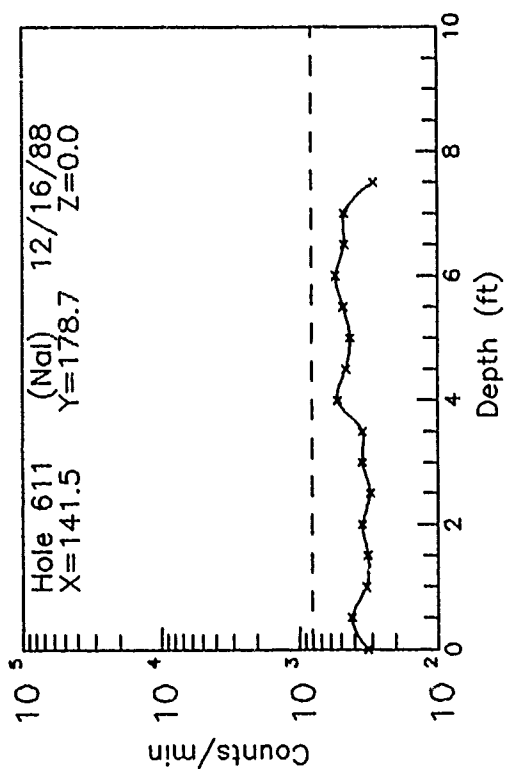


Figure C130. Subsurface Data from Stratford Sewer in Map Region 120

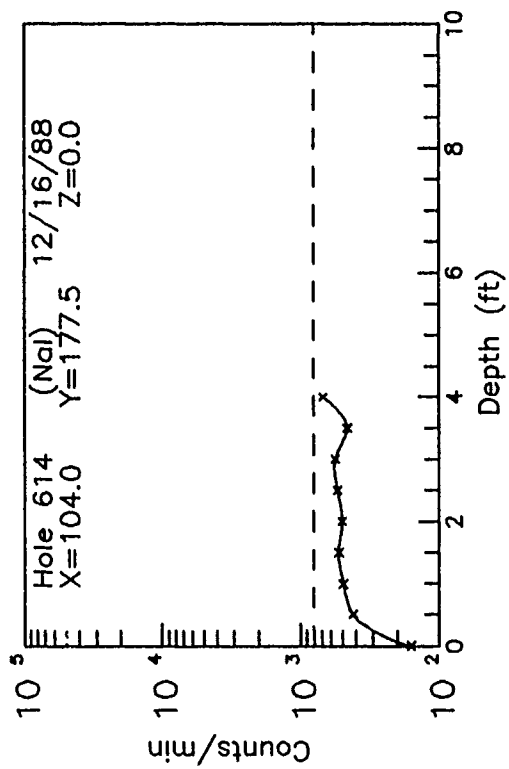
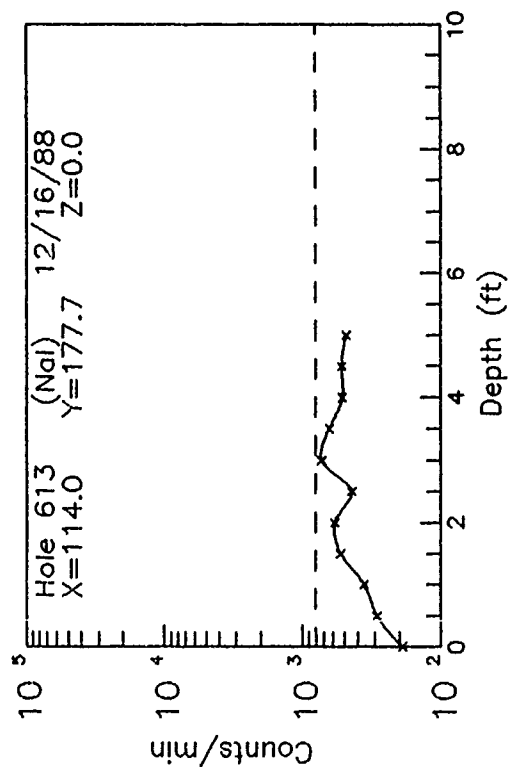
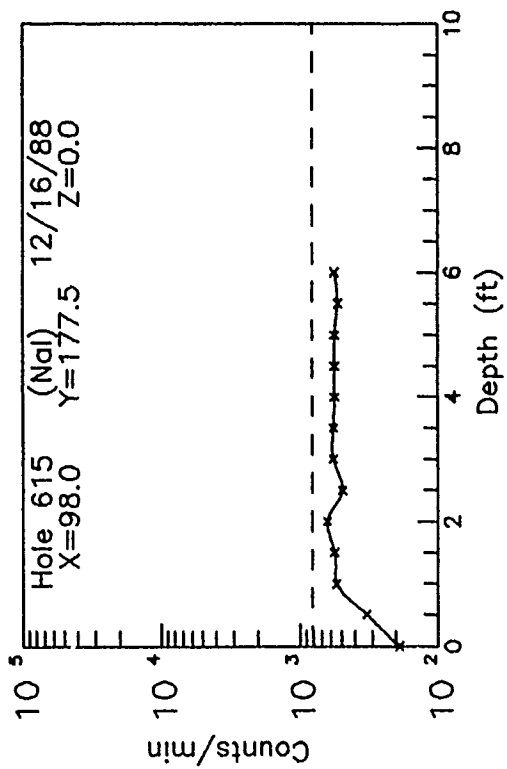
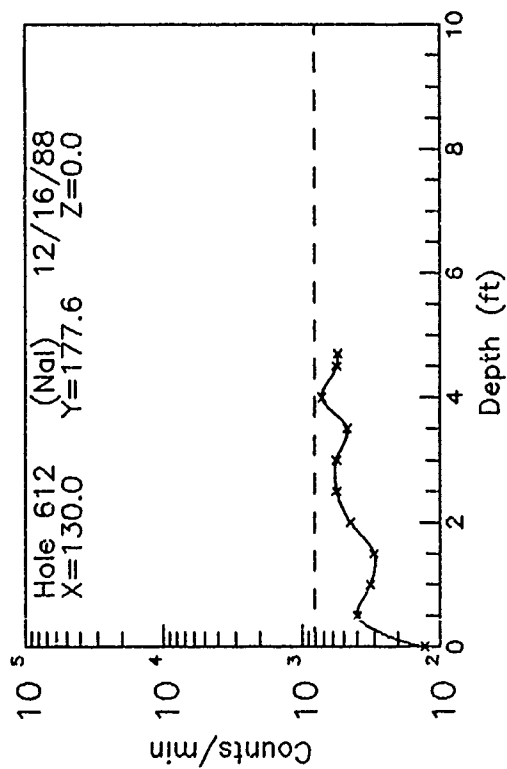


Figure C131. Subsurface Data from Stratford Sewer in Map Region 121

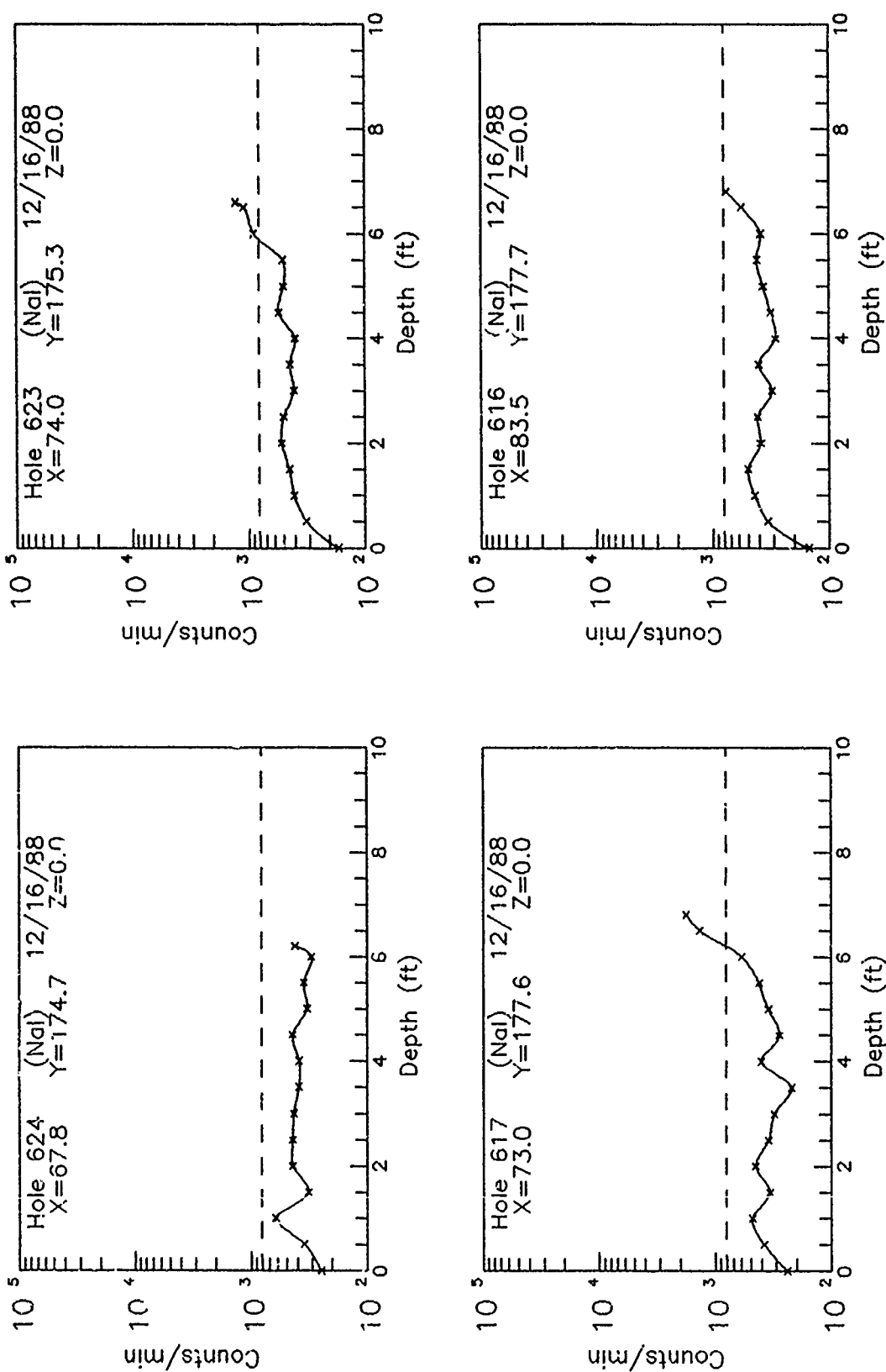


Figure C132. Subsurface Data from Stratford Sewer in Map Region 122

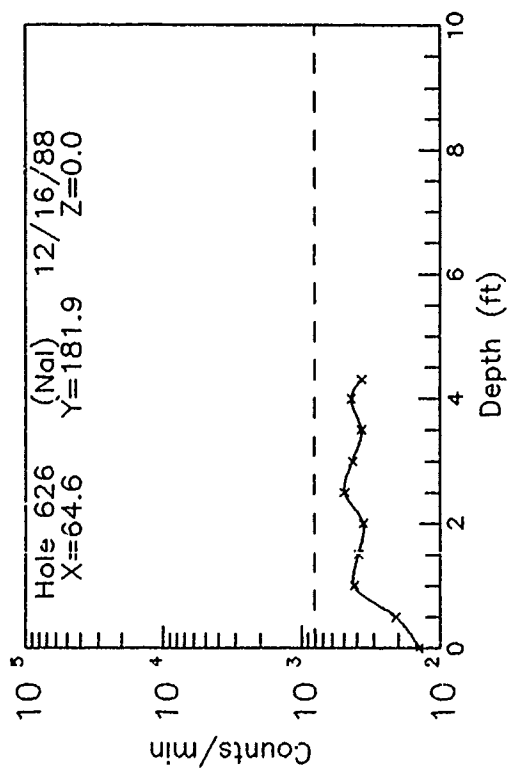
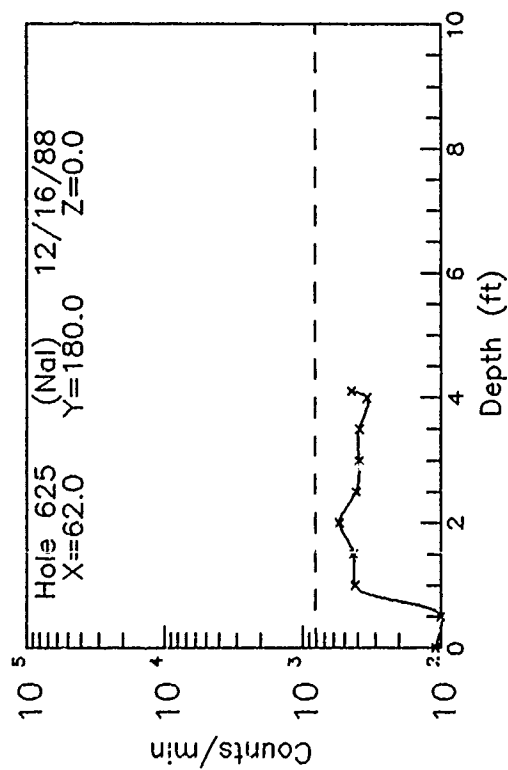
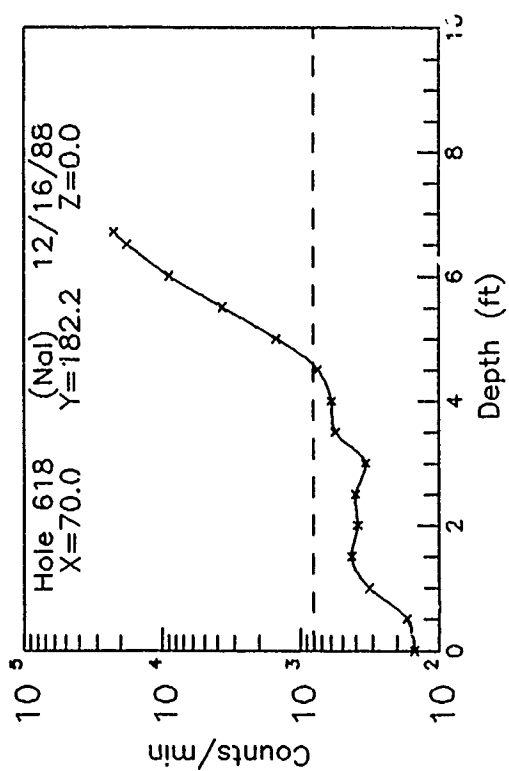
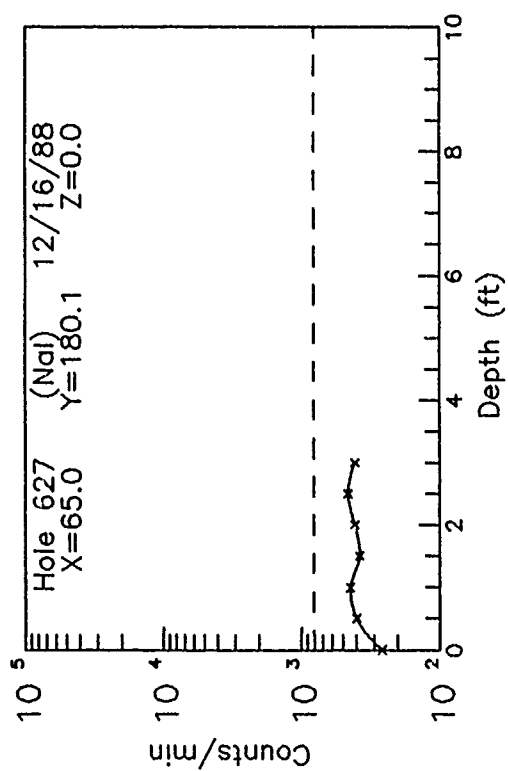


Figure C133. Subsurface Data from Stratford Sewer in Map Region 123

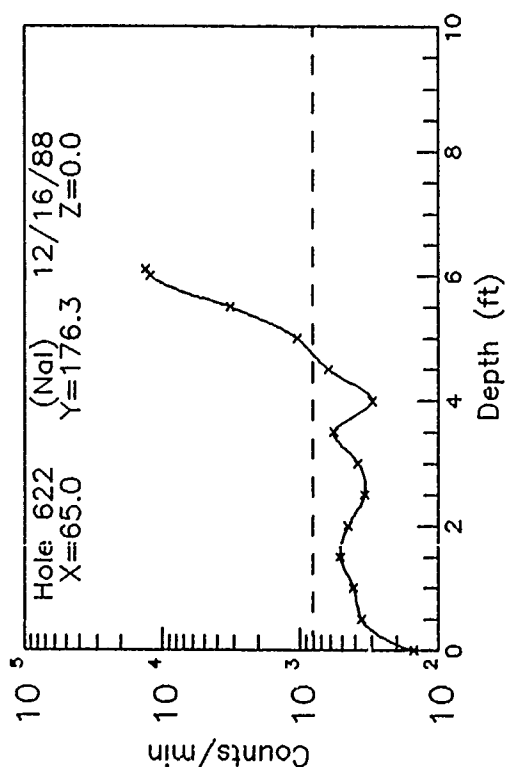
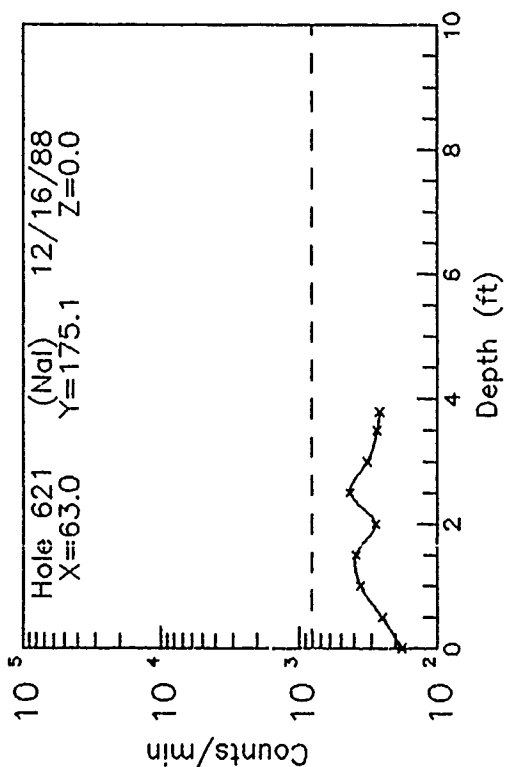
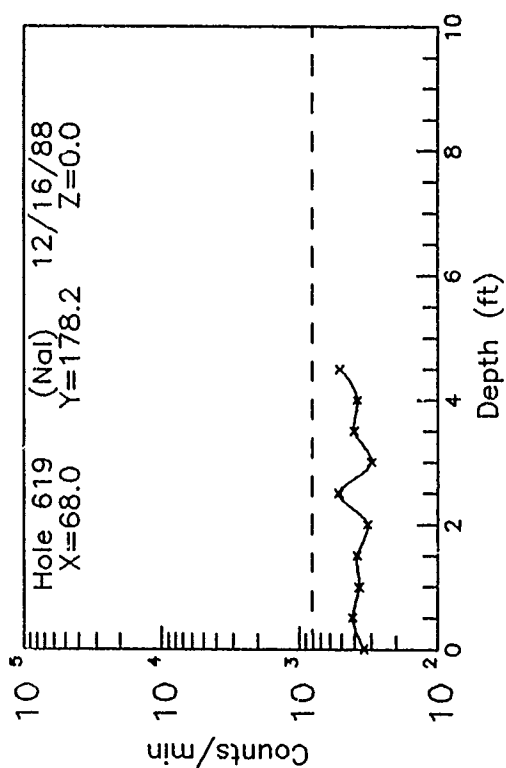
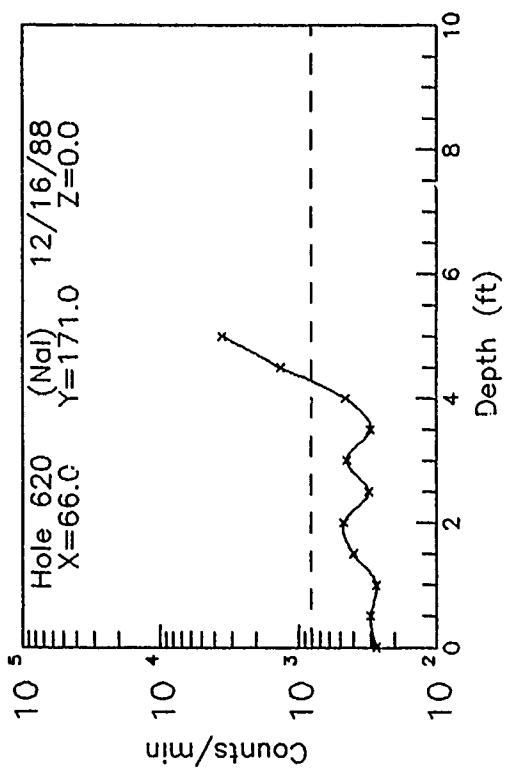


Figure C134. Subsurface Data from Stratford Sewer in Map Region 124

APPENDIX D

APPENDIX D

TABULATED RESULTS OF SAMPLE ANALYSES

- Table D.1 Ra-226 Analyses of Union Avenue Soil Borings
- Table D.2 Th-232 and K-40 Analyses of Union Avenue Soil Borings
- Table D.3 Ra-226 Analyses of Soil Samples Collected Near Soil Tubes
- Table D.4 Th-232 and K-40 Analyses of Soil Samples Collected Near Soil Tubes
- Table D.5 Ra-226 Analyses of Soil Samples Collected at Test Plot
- Table D.6 Th-232 and K-40 Analyses of Soil Samples Collected at Test Plot
- Table D.7 Ra-226 Analyses of Soil Samples Collected Along Stratford Sewer Line
- Table D.8 Th-232 and K-40 Analyses of Soil Samples Collected Along Stratford Sewer Line
- Table D.9 Ra-226 Analyses of Final Verification Soil Samples
- Table D.10 Th-232 and K-40 Analyses of Final Verification Soil Samples
- Table D.11 Ra-226 Analyses of Backfill Soil
- Table D.12 Th-232 and K-40 Analyses of Backfill Soil

Note: All of the initial and aged results are field results counted for 20 minutes. For samples with an asterisk (*) before the sample number, the dried analyses were conducted by ACL and are reported on a dry weight basis. The heading "initial" refers to soil samples analyzed at the mobile laboratory in the field shortly after sample preparation. "Aged" refers to soil samples analyzed at the mobile laboratory in the field 20 days after sample preparation. And "dried" refers to soil samples which were dried and re-analyzed back at Argonne after the site activities were completed. The column "Dry Wt %" is the dry sample weight divided by the wet sample weight expressed as a percentage.

TABLE D.1 Ra-226 Analyses of Union Avenue Soil Borings

Sample No.	Depth Ft.	Hole No.	Dry Wt %	Ra-226 (186 keV)			Pb-214 (352 keV)			Bi-214 (609 keV)		
				--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
				pCi/g \pm σ	pCi/g \pm σ	pCi/g \pm σ	pCi/g \pm σ	pCi/g \pm σ	pCi/g \pm σ	pCi/g \pm σ	pCi/g \pm σ	pCi/g \pm σ
22-S-328	1.3- 2.5	1	88.4	BDL	BDL	BDL	0.53 \pm 0.08	0.53 \pm 0.08	0.89 \pm 0.10	0.77 \pm 0.10	0.56 \pm 0.09	1.02 \pm 0.11
22-S-329	2.5- 4.0	1	93.4	1.11 \pm 0.60	BDL	2.35 \pm 0.84	0.42 \pm 0.08	0.26 \pm 0.08	0.79 \pm 0.11	0.53 \pm 0.11	0.41 \pm 0.09	0.64 \pm 0.11
22-S-330	4.0- 5.5	1	87.6	1.15 \pm 0.55	BDL	BDL	0.47 \pm 0.07	0.41 \pm 0.08	0.64 \pm 0.09	0.55 \pm 0.09	0.34 \pm 0.09	0.75 \pm 0.10
22-S-331	5.5- 7.0	1	91.6	BDL	BDL	BDL	0.40 \pm 0.07	0.19 \pm 0.06	0.74 \pm 0.09	0.38 \pm 0.09	0.31 \pm 0.08	0.64 \pm 0.10
22-S-332	7.0- 8.5	1	86.5	1.29 \pm 0.54	BDL	2.19 \pm 0.84	0.51 \pm 0.08	0.37 \pm 0.07	0.81 \pm 0.12	0.57 \pm 0.11	0.37 \pm 0.08	0.96 \pm 0.11
22-S-332	8.5-10.0	1	80.1	1.32 \pm 0.58	BDL	4.55 \pm 1.00	0.68 \pm 0.08	0.40 \pm 0.06	1.29 \pm 0.12	0.68 \pm 0.10	0.45 \pm 0.09	1.40 \pm 0.13
22-S-326	10.0-11.5	1	83.9	BDL	BDL	BDL	0.51 \pm 0.08	0.48 \pm 0.07	0.94 \pm 0.10	0.69 \pm 0.11	0.53 \pm 0.09	0.90 \pm 0.11
22-S-333	1.0- 2.5	2	91.4	1.23 \pm 0.49	BDL	BDL	0.67 \pm 0.08	0.47 \pm 0.07	0.79 \pm 0.09	0.68 \pm 0.11	0.37 \pm 0.09	0.66 \pm 0.10
22-S-334	2.5- 4.0	2	93.2	BDL	BDL	2.57 \pm 0.80	0.43 \pm 0.08	0.57 \pm 0.07	0.78 \pm 0.09	0.51 \pm 0.11	0.57 \pm 0.09	0.70 \pm 0.10
22-S-335	4.0- 5.5	2	91.7	BDL	1.72 \pm 0.63	1.96 \pm 0.74	0.60 \pm 0.08	0.61 \pm 0.07	1.12 \pm 0.11	0.73 \pm 0.10	0.53 \pm 0.09	0.73 \pm 0.12
22-S-336	5.5- 7.0	2	92.6	BDL	1.30 \pm 0.49	BDL	0.29 \pm 0.07	0.49 \pm 0.07	0.77 \pm 0.09	0.53 \pm 0.10	0.53 \pm 0.08	0.66 \pm 0.10
22-S-337	7.0- 8.5	2	91.9	BDL	BDL	BDL	0.30 \pm 0.06	0.26 \pm 0.06	0.51 \pm 0.09	0.33 \pm 0.08	0.44 \pm 0.08	0.44 \pm 0.10
22-S-338	8.5-10.0	2	85.9	BDL	0.99 \pm 0.47	2.06 \pm 0.86	0.43 \pm 0.07	0.52 \pm 0.07	1.34 \pm 0.11	0.69 \pm 0.10	0.42 \pm 0.08	0.93 \pm 0.11
22-S-339	10.0-10.7	2	86.9	BDL	BDL	1.66 \pm 0.75	0.25 \pm 0.07	0.32 \pm 0.07	0.40 \pm 0.09	0.37 \pm 0.09	0.25 \pm 0.08	0.71 \pm 0.10
22-S-340	1.0- 2.5	3	91.7	1.12 \pm 0.53	1.61 \pm 0.54	1.69 \pm 0.64	0.57 \pm 0.08	0.66 \pm 0.08	0.93 \pm 0.10	0.67 \pm 0.11	0.88 \pm 0.10	0.97 \pm 0.11
22-S-341	2.5- 4.0	3	93.9	BDL	BDL	BDL	0.36 \pm 0.07	0.32 \pm 0.06	0.64 \pm 0.09	0.33 \pm 0.09	0.39 \pm 0.07	0.54 \pm 0.09
22-S-342	4.0- 5.5	3	93.8	BDL	BDL	BDL	0.17 \pm 0.07	0.27 \pm 0.06	0.54 \pm 0.09	0.40 \pm 0.10	0.36 \pm 0.08	0.55 \pm 0.10
22-S-343	5.5- 7.0	3	92.5	BDL	BDL	BDL	0.23 \pm 0.06	0.32 \pm 0.07	0.58 \pm 0.09	0.51 \pm 0.10	0.36 \pm 0.07	0.52 \pm 0.10
22-S-344	7.0- 8.5	3	88.1	BDL	BDL	BDL	0.42 \pm 0.07	0.58 \pm 0.08	0.91 \pm 0.11	0.46 \pm 0.10	0.54 \pm 0.09	0.77 \pm 0.11
22-S-345	8.5-10.0	3	80.4	0.88 \pm 0.41	BDL	2.43 \pm 0.86	0.44 \pm 0.07	0.61 \pm 0.08	0.90 \pm 0.12	0.65 \pm 0.10	0.46 \pm 0.09	0.84 \pm 0.11
22-S-346	10.0-11.3	3	85.5	BDL	BDL	BDL	0.41 \pm 0.07	0.50 \pm 0.08	0.74 \pm 0.10	0.56 \pm 0.09	0.58 \pm 0.08	0.58 \pm 0.11
22-S-348	0.5- 2.0	4	87.4	0.81 \pm 0.44	BDL	2.11 \pm 0.69	0.50 \pm 0.07	0.58 \pm 0.07	0.75 \pm 0.09	0.64 \pm 0.09	0.51 \pm 0.08	0.65 \pm 0.09
22-S-349	2.0- 3.5	4	89.0	1.15 \pm 0.51	1.56 \pm 0.50	BDL	0.48 \pm 0.08	0.56 \pm 0.07	0.79 \pm 0.09	0.66 \pm 0.10	0.60 \pm 0.09	0.82 \pm 0.09
22-S-350	3.5- 5.0	4	90.9	BDL	BDL	1.83 \pm 0.75	0.61 \pm 0.08	0.56 \pm 0.07	0.94 \pm 0.10	0.65 \pm 0.12	0.62 \pm 0.09	1.06 \pm 0.11
22-S-351	5.0- 6.5	4	87.9	1.76 \pm 0.50	2.34 \pm 0.56	1.81 \pm 0.70	0.70 \pm 0.08	0.71 \pm 0.07	1.44 \pm 0.11	1.20 \pm 0.12	0.72 \pm 0.09	1.28 \pm 0.10
22-S-352	6.5- 8.0	4	90.9	BDL	BDL	BDL	0.47 \pm 0.07	0.30 \pm 0.06	0.65 \pm 0.08	0.64 \pm 0.11	0.34 \pm 0.07	0.60 \pm 0.09
22-S-353	8.0- 9.2	4	83.6	1.10 \pm 0.46	1.49 \pm 0.49	1.60 \pm 0.63	0.68 \pm 0.07	0.56 \pm 0.07	1.03 \pm 0.09	0.84 \pm 0.10	0.52 \pm 0.08	0.98 \pm 0.09
Ave			88.9	1.17	1.53	2.22	0.46	0.46	0.84	0.60	0.48	0.79
Std dev			3.9	0.24	0.38	0.73	0.14	0.14	0.24	0.18	0.14	0.23
Max			93.9	1.76	2.34	4.55	0.70	0.71	1.44	1.20	0.88	1.40
Min			80.1	0.81	0.99	1.60	0.17	0.19	0.40	0.33	0.25	0.44
No. of Samples			27	11	8	13	27	27	27	27	27	27

TABLE D.1 (Cont'd)

Sample No.	Depth Ft	Hole No.	Dry Wt %	Ra-226 (186 keV)			Pb-214 (352 keV)			Bi-214 (609 keV)		
				--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
				pCi/g \pm σ	pCi/g \pm σ	pCi/g \pm σ	pCi/g \pm σ	pCi/g \pm σ	pCi/g \pm σ	pCi/g \pm σ	pCi/g \pm σ	pCi/g \pm σ
22-S-354	1.0- 2.5	5	94.3	1.02 \pm 0.42	BDL	2.03 \pm 0.58	0.39 \pm 0.07	0.43 \pm 0.05	0.57 \pm 0.08	0.58 \pm 0.09	0.51 \pm 0.07	0.57 \pm 0.08
22-S-355	2.5- 4.0	5	95.4	BDL	BDL	BDL	0.52 \pm 0.07	0.47 \pm 0.06	0.67 \pm 0.08	0.58 \pm 0.09	0.50 \pm 0.07	0.54 \pm 0.08
22-S-356	4.0- 5.5	5	95.1	1.16 \pm 0.43	1.27 \pm 0.44	1.41 \pm 0.57	0.39 \pm 0.06	0.48 \pm 0.05	0.80 \pm 0.08	0.54 \pm 0.08	0.31 \pm 0.06	0.69 \pm 0.08
22-S-357	5.5- 7.0	5	94.3	BDL	BDL	BDL	0.26 \pm 0.07	0.33 \pm 0.06	0.49 \pm 0.09	0.38 \pm 0.09	0.30 \pm 0.07	0.55 \pm 0.08
22-S-358	7.0- 8.5	5	88.6	BDL	1.32 \pm 0.40	1.48 \pm 0.62	0.29 \pm 0.06	0.27 \pm 0.05	0.60 \pm 0.08	0.46 \pm 0.08	0.30 \pm 0.07	0.65 \pm 0.09
22-S-359	8.5-10.0	5	88.5	1.47 \pm 0.42	0.72 \pm 0.35	2.18 \pm 0.70	0.25 \pm 0.06	0.38 \pm 0.05	0.68 \pm 0.08	0.40 \pm 0.07	0.31 \pm 0.06	0.62 \pm 0.09
22-S-360	10.0-11.5	5	90.6	BDL	1.06 \pm 0.45	2.04 \pm 0.70	0.30 \pm 0.06	0.30 \pm 0.06	0.60 \pm 0.08	0.25 \pm 0.07	0.43 \pm 0.06	0.58 \pm 0.09
Ave			92.4	1.22	1.09	1.83	0.34	0.38	0.63	0.45	0.38	0.60
Std dev			2.8	0.19	0.23	0.32	0.09	0.08	0.09	0.11	0.09	0.05
Max			95.4	1.47	1.32	2.12	0.52	0.48	0.80	0.58	0.51	0.69
Min			88.5	1.02	0.72	1.41	0.25	0.27	0.49	0.25	0.30	0.54
No. of Samples			7	3	4	5	7	7	7	7	7	7

uncertainty in the counting statistics.

BDL = Below Detectable Level.

TABLE D.2 Th-232 and K-40 Analyses of Union Avenue Soil Borings

Sample No.	Depth Ft	Hole No.	Dry Wt %	Th-232 (911 keV) pCi/g \pm σ			K-40 (1460 keV) pCi/g \pm σ		
				--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
22-S-328	1.0- 2.5	1	88.4	0.97 \pm 0.24	0.94 \pm 0.17	0.85 \pm 0.18	25.7 \pm 1.8	17.7 \pm 1.3	17.6 \pm 1.1
22-S-329	2.5- 4.0	1	93.4	1.23 \pm 0.28	1.04 \pm 0.22	1.14 \pm 0.21	31.0 \pm 2.0	20.7 \pm 1.4	17.1 \pm 1.3
22-S-330	4.0- 5.5	1	87.6	1.08 \pm 0.25	1.23 \pm 0.18	0.98 \pm 0.20	29.7 \pm 1.8	21.2 \pm 1.3	18.2 \pm 1.2
22-S-331	5.5- 7.0	1	91.6	1.05 \pm 0.24	0.89 \pm 0.19	1.15 \pm 0.21	26.4 \pm 1.8	18.3 \pm 1.2	16.3 \pm 1.1
22-S-332	7.0- 8.5	1	86.5	1.22 \pm 0.28	0.98 \pm 0.21	1.17 \pm 0.21	29.3 \pm 1.9	22.1 \pm 1.4	16.9 \pm 1.3
22-S-327	8.5-10.0	1	80.1	1.19 \pm 0.24	1.14 \pm 0.19	1.19 \pm 0.22	27.4 \pm 1.7	21.4 \pm 1.3	21.1 \pm 1.4
22-S-326	10.0-11.5	1	83.9	1.45 \pm 0.23	1.08 \pm 0.21	1.35 \pm 0.19	24.5 \pm 1.8	17.9 \pm 1.3	18.2 \pm 1.2
22-S-333	1.0- 2.5	2	91.4	1.53 \pm 0.28	0.93 \pm 0.19	1.15 \pm 0.20	26.3 \pm 1.8	20.1 \pm 1.3	17.0 \pm 1.2
22-S-334	2.5- 4.0	2	93.2	1.60 \pm 0.26	1.31 \pm 0.21	1.91 \pm 0.23	42.2 \pm 2.1	31.2 \pm 1.4	23.3 \pm 1.3
22-S-335	4.0- 5.5	2	91.7	1.74 \pm 0.26	1.29 \pm 0.20	1.10 \pm 0.21	33.5 \pm 1.9	20.5 \pm 1.3	18.3 \pm 1.2
22-S-336	5.5- 7.0	2	92.6	1.32 \pm 0.25	1.00 \pm 0.19	0.97 \pm 0.20	32.6 \pm 1.9	27.7 \pm 1.4	23.4 \pm 1.3
22-S-337	7.0- 8.5	2	91.9	0.92 \pm 0.24	0.60 \pm 0.18	0.92 \pm 0.19	29.9 \pm 1.8	23.5 \pm 1.2	20.0 \pm 1.2
22-S-338	8.5-10.0	2	85.9	1.11 \pm 0.23	0.68 \pm 0.17	1.21 \pm 0.21	29.7 \pm 1.9	20.8 \pm 1.3	19.1 \pm 1.3
22-S-339	10.0-10.7	2	86.9	1.02 \pm 0.22	1.00 \pm 0.19	0.98 \pm 0.20	24.5 \pm 1.7	20.9 \pm 1.3	17.0 \pm 1.3
22-S-340	1.0- 2.5	3	91.7	1.38 \pm 0.23	1.29 \pm 0.18	1.07 \pm 0.21	24.0 \pm 1.8	18.1 \pm 1.3	18.0 \pm 1.3
22-S-341	2.5- 4.0	3	93.9	1.18 \pm 0.24	1.38 \pm 0.20	1.17 \pm 0.21	29.0 \pm 1.9	24.3 \pm 1.3	21.3 \pm 1.2
22-S-342	4.0- 5.5	3	93.8	1.29 \pm 0.27	1.00 \pm 0.19	0.88 \pm 0.21	32.7 \pm 1.8	19.6 \pm 1.3	19.7 \pm 1.2
22-S-343	5.5- 7.0	3	92.5	1.38 \pm 0.24	1.00 \pm 0.19	0.98 \pm 0.20	32.1 \pm 1.9	23.0 \pm 1.3	20.9 \pm 1.3
22-S-344	7.0- 8.5	3	88.1	1.10 \pm 0.24	0.89 \pm 0.20	1.16 \pm 0.23	28.0 \pm 1.9	19.6 \pm 1.3	18.6 \pm 1.3
22-S-345	8.5-10.0	3	80.4	1.49 \pm 0.20	0.57 \pm 0.19	0.71 \pm 0.24	18.6 \pm 1.7	14.9 \pm 1.2	15.9 \pm 1.2
22-S-346	10.0-11.3	3	85.5	1.05 \pm 0.21	0.68 \pm 0.18	1.10 \pm 0.20	27.3 \pm 1.8	17.2 \pm 1.2	18.4 \pm 1.2
22-S-348	0.5- 2.0	4	87.4	1.09 \pm 0.21	0.51 \pm 0.17	0.84 \pm 0.18	28.4 \pm 1.8	20.1 \pm 1.2	19.5 \pm 1.2
22-S-349	2.0- 3.5	4	89.0	1.44 \pm 0.26	0.77 \pm 0.19	1.02 \pm 0.18	21.2 \pm 1.8	15.2 \pm 1.2	14.5 \pm 1.1
22-S-350	3.5- 5.0	4	90.9	1.33 \pm 0.23	1.35 \pm 0.20	1.13 \pm 0.19	29.7 \pm 1.8	20.6 \pm 1.3	14.8 \pm 1.1
22-S-351	5.0- 6.5	4	87.9	1.44 \pm 0.24	0.97 \pm 0.18	0.77 \pm 0.18	30.5 \pm 1.9	21.4 \pm 1.3	15.1 \pm 1.0
22-S-352	6.5- 8.0	4	90.9	1.31 \pm 0.24	0.67 \pm 0.16	0.58 \pm 0.17	23.4 \pm 1.7	18.0 \pm 1.2	18.1 \pm 1.1
22-S-353	8.0- 9.2	4	83.6	1.03 \pm 0.24	0.76 \pm 0.16	0.89 \pm 0.17	22.8 \pm 1.6	16.8 \pm 1.2	16.0 \pm 1.0
Ave			88.9	1.26	0.96	1.05	28.2	20.5	18.3
Std dev			3.9	0.21	0.24	0.24	4.5	3.4	2.3
Max			93.9	1.74	1.38	1.91	42.2	31.2	23.4
Min			80.1	0.92	0.51	0.58	18.5	14.9	14.5
No. of Samples			27	27	27	27	27	27	27

TABLE D.2 (Cont'd)

Sample No.	Depth ft	Hole No.	Dry Wt %	Th-232 (911 keV) pCi/g \pm σ			K-40 (1460 keV) pCi/g \pm σ		
				--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
22-S-354	1.0- 2.5	5	94.3	0.47 \pm 0.16	0.33 \pm 0.13	BDL	23.5 \pm 1.6	17.2 \pm 1.1	14.5 \pm 1.0
22-S-355	2.5- 4.0	5	95.4	0.44 \pm 0.19	BDL	BDL	38.2 \pm 1.9	27.7 \pm 1.3	23.6 \pm 1.2
22-S-356	4.0- 5.5	5	95.1	BDL	BDL	BDL	12.7 \pm 1.2	10.5 \pm 0.9	7.1 \pm 0.8
22-S-357	5.5- 7.0	5	94.3	BDL	BDL	BDL	24.0 \pm 1.6	16.1 \pm 1.1	16.9 \pm 1.1
22-S-358	7.0- 8.5	5	86.6	BDL	BDL	BDL	38.1 \pm 1.9	25.4 \pm 1.2	24.0 \pm 1.2
22-S-359	8.5-10.0	5	88.5	0.39 \pm 0.19	0.21 \pm 0.13	BDL	43.3 \pm 1.8	32.6 \pm 1.3	30.4 \pm 1.3
22-S-360	10.0-11.5	5	90.6	BDL	BDL	BDL	37.9 \pm 1.8	27.4 \pm 1.3	28.6 \pm 1.3
Ave			92.4	0.43	0.27		31.1	22.4	20.7
Std dev			2.8	0.03	0.06		10.3	7.3	7.7
dx			95.4	0.47	0.33		43.3	32.6	30.4
Min			88.5	0.39	0.21		12.7	10.5	7.1
No. of Samples			7	3	2	0	7	7	7

Uncertainty in the counting statistics.

BDL = Below Detectable Level.

TABLE D.3 Ra-226 Analyses of Soil Samples Collected Near Soil Tubes

Sample No.	Reg. No.	Hole No.	Depth in.	Dry Wt %	Ra-226 (186 keV)			Pb-214 (352 keV)			Bi-214 (609 keV)		
					--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
pCi/g $\pm \sigma$													
Zone Number 1													
22-Z-434	3	701	0-6	96.9	BDL	BDL	BDL	1.18 \pm 0.14	1.11 \pm 0.16	1.55 \pm 0.18	1.39 \pm 0.17	1.09 \pm 0.16	1.49 \pm 0.19
22-S-435	3	701	12-18	88.2	2.77 \pm 0.61	1.62 \pm 0.73	3.75 \pm 1.17	1.24 \pm 0.10	1.69 \pm 0.11	1.60 \pm 0.16	1.44 \pm 0.12	1.59 \pm 0.12	1.74 \pm 0.17
22-S-436	3	701	18-20	86.1	1.39 \pm 0.64	2.12 \pm 0.65	BDL	0.95 \pm 0.09	1.03 \pm 0.10	1.37 \pm 0.15	1.22 \pm 0.12	1.12 \pm 0.12	1.46 \pm 0.16
22-Z-438	3	702	0-6	94.1	1.13 \pm 0.62	2.44 \pm 0.82	BDL	0.93 \pm 0.11	1.17 \pm 0.12	0.93 \pm 0.18	1.28 \pm 0.14	1.22 \pm 0.14	0.73 \pm 0.18
22-S-439	3	702	12-14	88.9	BDL	BDL	BDL	0.74 \pm 0.08	0.90 \pm 0.09	1.00 \pm 0.14	0.78 \pm 0.10	0.82 \pm 0.11	1.30 \pm 0.15
22-S-440	4	703	0-6	94.5	1.56 \pm 0.74	1.70 \pm 0.80	3.39 \pm 1.20	1.05 \pm 0.11	1.16 \pm 0.11	0.99 \pm 0.14	1.27 \pm 0.12	1.12 \pm 0.13	1.19 \pm 0.15
22-S-441	4	703	9-12	88.6	1.61 \pm 0.59	1.73 \pm 0.61	BDL	0.78 \pm 0.09	1.01 \pm 0.09	1.18 \pm 0.13	0.50 \pm 0.12	1.14 \pm 0.11	1.25 \pm 0.14
22-S-442	4	703	12-14	86.9	BDL	1.93 \pm 0.75	2.24 \pm 0.92	1.06 \pm 0.10	1.31 \pm 0.10	1.34 \pm 0.14	0.97 \pm 0.12	1.47 \pm 0.12	1.81 \pm 0.15
Zone Number 2													
22-S-279	99	332	0-3.5	88.4	26.6 \pm 1.22	27.6 \pm 1.26	48.3 \pm 2.40	15.0 \pm 0.27	21.7 \pm 0.30	36.8 \pm 0.46	19.5 \pm 0.37	28.1 \pm 0.43	37.7 \pm 0.50
22-S-280	99	332	3.5-6.5	91.8	8.84 \pm 0.94	9.07 \pm 0.94	15.3 \pm 1.41	5.24 \pm 0.17	9.19 \pm 0.21	12.7 \pm 0.26	6.64 \pm 0.24	11.2 \pm 0.29	11.6 \pm 0.29
22-S-281	99	332	6.5-8.5	90.5	18.1 \pm 1.20	14.0 \pm 1.24	25.1 \pm 2.20	9.75 \pm 0.22	14.1 \pm 0.27	19.5 \pm 0.36	12.6 \pm 0.31	18.0 \pm 0.36	19.5 \pm 0.39
22-S-284	99	334	0-3.3	89.3	3.46 \pm 0.68	2.59 \pm 0.53	4.70 \pm 0.94	1.35 \pm 0.11	2.01 \pm 0.11	3.49 \pm 0.17	1.66 \pm 0.15	2.38 \pm 0.15	3.32 \pm 0.18
22-S-285	99	334	3.3-6.0	86.9	4.36 \pm 0.85	6.19 \pm 0.75	8.31 \pm 1.14	2.66 \pm 0.13	4.17 \pm 0.15	6.66 \pm 0.21	3.99 \pm 0.18	4.72 \pm 0.20	6.67 \pm 0.24
22-S-286	99	334	5.0-7.5	84.5	3.66 \pm 0.54	4.91 \pm 0.93	8.47 \pm 1.20	1.49 \pm 0.10	2.38 \pm 0.15	4.29 \pm 0.22	1.96 \pm 0.13	2.92 \pm 0.21	4.24 \pm 0.24
22-S-287	100	335	0-3.5	88.3	52.5 \pm 1.94	56.4 \pm 2.41	48.1 \pm 2.99	58.8 \pm 0.48	67.4 \pm 0.51	42.4 \pm 0.52	75.2 \pm 0.68	83.6 \pm 0.71	45.6 \pm 0.54
22-S-288	100	335	3.5-6.0	92.9	3.26 \pm 0.80	3.75 \pm 0.76	6.12 \pm 0.93	2.10 \pm 0.12	2.83 \pm 0.14	3.36 \pm 0.15	2.74 \pm 0.17	2.91 \pm 0.19	3.08 \pm 0.16
22-S-302	100	661	0-3.7	87.7	11.0 \pm 0.95	10.7 \pm 0.82	14.7 \pm 1.45	5.68 \pm 0.17	6.63 \pm 0.18	13.20 \pm 0.28	6.42 \pm 0.23	8.07 \pm 0.24	12.8 \pm 0.30
22-S-303	100	661	3.7-6.0	89.6	6.22 \pm 0.92	6.33 \pm 0.89	8.30 \pm 1.41	3.00 \pm 0.16	4.55 \pm 0.18	7.52 \pm 0.25	3.18 \pm 0.21	5.43 \pm 0.24	6.85 \pm 0.27
22-S-278	103	330	0-4.0	79.6	27.9 \pm 1.35	31.3 \pm 1.48	58.9 \pm 3.12	21.1 \pm 0.29	37.8 \pm 0.39	44.4 \pm 0.53	25.3 \pm 0.41	46.9 \pm 0.53	43.1 \pm 0.57
22-S-321	104	347	17	80.8	8.41 \pm 0.72	7.75 \pm 0.75	12.2 \pm 1.13	3.46 \pm 0.13	4.83 \pm 0.13	7.89 \pm 0.19	4.65 \pm 0.17	5.52 \pm 0.17	7.95 \pm 0.21
22-S-299	104	347	18	93.6	3.66 \pm 0.58	2.99 \pm 0.56	5.83 \pm 1.05	1.30 \pm 0.10	2.36 \pm 0.11	3.18 \pm 0.14	1.14 \pm 0.13	2.64 \pm 0.15	3.11 \pm 0.15
22-S-301	104	347	24	93.5	2.01 \pm 0.56	2.37 \pm 0.55	2.42 \pm 0.85	0.89 \pm 0.09	1.22 \pm 0.10	2.09 \pm 0.12	1.09 \pm 0.12	1.48 \pm 0.13	2.02 \pm 0.13
22-S-300	104	347	30	88.0	4.42 \pm 0.68	5.26 \pm 0.71	NA	1.70 \pm 0.11	2.88 \pm 0.13	3.48 \pm 0.09	2.00 \pm 0.14	3.50 \pm 0.18	3.22 \pm 0.06
22-S-300	104	347	30	88.5	4.42 \pm 0.68	5.26 \pm 0.71	9.29 \pm 1.09	1.70 \pm 0.11	2.88 \pm 0.13	4.11 \pm 0.17	2.00 \pm 0.14	3.50 \pm 0.18	3.96 \pm 0.18
22-S-298	104	347	36	90.6	5.01 \pm 0.69	4.65 \pm 0.75	NA	1.83 \pm 0.13	2.65 \pm 0.14	2.83 \pm 0.07	1.95 \pm 0.16	3.12 \pm 0.17	2.59 \pm 0.09
22-S-298	104	347	36	89.9	5.01 \pm 0.69	4.65 \pm 0.75	8.49 \pm 1.13	1.83 \pm 0.13	2.65 \pm 0.14	4.00 \pm 0.18	1.95 \pm 0.16	3.12 \pm 0.17	3.89 \pm 0.19
22-S-276	105	329	0-3.5	86.3	40.3 \pm 1.44	39.3 \pm 1.61	67.9 \pm 2.97	21.9 \pm 0.29	39.1 \pm 0.38	56.7 \pm 0.56	27.8 \pm 0.41	49.7 \pm 0.54	55.1 \pm 0.61
22-S-277	105	329	3.5-5.5	87.2	45.1 \pm 1.75	40.6 \pm 1.75	71.8 \pm 3.35	21.2 \pm 0.36	36.4 \pm 0.46	55.0 \pm 0.67	26.4 \pm 0.49	45.4 \pm 0.63	51.6 \pm 0.71
22-S-273	106	328	0-3.0	75.1	3.04 \pm 0.84	3.71 \pm 0.81	3.82 \pm 1.47	1.77 \pm 0.14	3.42 \pm 0.18	5.13 \pm 0.26	1.97 \pm 0.20	4.39 \pm 0.24	4.70 \pm 0.27
22-S-274	106	328	3.0-5.2	83.5	BDL	1.44 \pm 0.53	BDL	0.66 \pm 0.10	0.80 \pm 0.10	1.15 \pm 0.13	0.71 \pm 0.13	0.86 \pm 0.13	1.32 \pm 0.14
22-S-275	107	344	0-24	90.3	3.13 \pm 0.83	BDL	BDL	0.64 \pm 0.10	0.83 \pm 0.11	1.14 \pm 0.12	0.85 \pm 0.14	0.91 \pm 0.14	1.18 \pm 0.14
22-S-275	107	344	0-24	90.3	3.13 \pm 0.83	BDL	BDL	0.64 \pm 0.10	0.83 \pm 0.11	1.14 \pm 0.12	0.85 \pm 0.14	0.91 \pm 0.14	1.18 \pm 0.14
22-S-282	108	333	0-4.5	84.1	2.10 \pm 0.58	1.32 \pm 0.58	2.73 \pm 0.97	0.67 \pm 0.09	1.01 \pm 0.10	2.48 \pm 0.16	1.13 \pm 0.15	0.98 \pm 0.15	2.39 \pm 0.15
22-S-283	108	333	4.5-7.0	77.7	1.33 \pm 0.48	BDL	3.71 \pm 0.95	0.51 \pm 0.08	0.74 \pm 0.08	1.52 \pm 0.15	0.53 \pm 0.10	0.72 \pm 0.10	1.54 \pm 0.15
22-S-270	109	323	0-3.0	90.6	2.57 \pm 0.71	1.90 \pm 0.72	2.63 \pm 0.80	0.72 \pm 0.10	0.90 \pm 0.11	1.46 \pm 0.12	0.86 \pm 0.14	1.08 \pm 0.14	1.52 \pm 0.13
22-S-271	109	323	3.0-6.0	91.7	BDL	BDL	2.38 \pm 0.99	0.72 \pm 0.09	0.91 \pm 0.10	1.29 \pm 0.12	0.88 \pm 0.13	0.99 \pm 0.14	1.18 \pm 0.13
22-S-272	109	323	6.0-9.5	90.6	1.50 \pm 0.58	1.82 \pm 0.55	4.78 \pm 1.03	0.67 \pm 0.10	1.12 \pm 0.10	1.69 \pm 0.14	0.88 \pm 0.13	1.15 \pm 0.14	1.57 \pm 0.14

TABLE D.3 (Cont'd)

Sample No.	Reg. No.	Hole No.	Depth in.	Dry Wt %	Ra-226 (186 keV)			Pb-214 (352 keV)			Bi-214 (609 keV)		
					--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
					pCi/g $\pm \sigma$			pCi/g $\pm \sigma$			pCi/g $\pm \sigma$		
Zone Number 4													
22-S-187	81	194	0-2.8	74.1	13.1 \pm 0.95	12.3 \pm 0.91	20.9 \pm 1.46	7.70 \pm 0.19	10.5 \pm 0.21	15.9 \pm 0.27	9.50 \pm 0.26	13.4 \pm 0.30	15.5 \pm 0.30
22-S-188	81	194	2.8-6.0	79.9	3.36 \pm 0.67	5.65 \pm 0.67	6.01 \pm 0.78	3.08 \pm 0.12	4.79 \pm 0.14	5.18 \pm 0.15	3.81 \pm 0.16	5.84 \pm 0.19	4.71 \pm 0.16
22-S-191	81	195	0-2.5	75.1	11.1 \pm 0.91	14.0 \pm 1.05	18.9 \pm 1.15	7.77 \pm 0.20	11.9 \pm 0.25	15.7 \pm 0.20	9.27 \pm 0.27	15.5 \pm 0.34	15.0 \pm 0.22
22-S-192	82	182	0-3.0	73.6	7.87 \pm 0.76	8.18 \pm 0.78	11.6 \pm 1.16	4.39 \pm 0.14	8.34 \pm 0.19	9.32 \pm 0.21	5.27 \pm 0.20	10.5 \pm 0.36	9.23 \pm 0.22
22-S-193	87	182	3.0-5.8	80.8	3.56 \pm 0.52	3.29 \pm 0.57	4.50 \pm 0.69	2.17 \pm 0.10	3.81 \pm 0.12	3.73 \pm 0.13	2.43 \pm 0.13	4.70 \pm 0.17	3.75 \pm 0.14
22-S-194	83	183	0-3.0	75.8	59.1 \pm 1.67	58.4 \pm 2.06	90.5 \pm 3.07	36.3 \pm 0.36	69.2 \pm 0.48	75.1 \pm 0.52	46.2 \pm 0.49	87.1 \pm 0.67	73.2 \pm 0.59
22-S-189	83	191	0-2.5	74.6	13.0 \pm 0.97	13.2 \pm 1.07	20.8 \pm 1.56	8.57 \pm 0.21	15.0 \pm 0.26	15.2 \pm 0.29	10.4 \pm 0.29	18.6 \pm 0.37	15.0 \pm 0.31
22-S-190	83	191	2.5-5.5	80.5	10.1 \pm 0.83	10.2 \pm 0.89	15.6 \pm 1.40	5.46 \pm 0.16	8.20 \pm 0.19	11.8 \pm 0.24	6.75 \pm 0.22	10.1 \pm 0.26	11.1 \pm 0.26
22-S-195	85	179	0-3.5	75.8	9.38 \pm 0.70	10.2 \pm 0.90	13.1 \pm 1.06	5.49 \pm 0.14	11.9 \pm 0.21	11.5 \pm 0.22	6.81 \pm 0.20	14.8 \pm 0.28	11.4 \pm 0.23
22-S-196	85	180	0-3.5	72.9	10.8 \pm 0.84	9.60 \pm 1.00	18.2 \pm 1.33	6.71 \pm 0.16	12.4 \pm 0.22	12.6 \pm 0.23	7.93 \pm 0.23	15.9 \pm 0.30	12.7 \pm 0.26
Zone Number 5													
22-S-291	71	341	0-4.0	91.8	2.47 \pm 0.76	1.98 \pm 0.67	BDL	0.82 \pm 0.10	1.16 \pm 0.11	1.42 \pm 0.14	1.10 \pm 0.14	1.29 \pm 0.15	1.64 \pm 0.15
22-S-292	71	341	4.0-7.2	90.7	4.17 \pm 0.86	3.73 \pm 0.81	6.82 \pm 1.13	2.57 \pm 0.15	2.73 \pm 0.14	5.68 \pm 0.22	3.50 \pm 0.20	3.54 \pm 0.19	4.94 \pm 0.22
22-S-293	71	341	7.2-9.0	91.3	2.91 \pm 0.76	1.97 \pm 0.64	4.31 \pm 0.89	1.11 \pm 0.12	1.61 \pm 0.12	3.15 \pm 0.16	1.57 \pm 0.15	1.88 \pm 0.16	2.65 \pm 0.17
22-S-294	71	341	9.0-12.3	90.6	2.19 \pm 0.62	1.74 \pm 0.66	3.96 \pm 1.12	1.24 \pm 0.11	1.49 \pm 0.12	2.37 \pm 0.16	1.53 \pm 0.15	1.61 \pm 0.15	2.41 \pm 0.16
22-S-289	96	339	0-5.5	85.2	23.1 \pm 1.13	22.0 \pm 1.40	32.1 \pm 2.09	12.5 \pm 0.24	20.4 \pm 0.30	29.8 \pm 0.42	14.9 \pm 0.33	25.3 \pm 0.42	30.2 \pm 0.47
22-S-290	96	339	5.5-8.0	90.9	2.03 \pm 0.65	2.10 \pm 0.52	5.21 \pm 1.05	1.53 \pm 0.12	1.74 \pm 0.12	3.26 \pm 0.17	1.86 \pm 0.15	1.99 \pm 0.15	2.82 \pm 0.18
Zone Number 6													
22-S-197	38	136	0-4.0	70.8	4.38 \pm 0.68	5.01 \pm 0.69	12.7 \pm 1.54	3.05 \pm 0.13	5.19 \pm 0.17	9.56 \pm 0.29	4.09 \pm 0.18	6.25 \pm 0.22	9.10 \pm 0.30
22-S-198	38	136	4.0-6.0	74.5	8.65 \pm 0.73	8.71 \pm 0.87	9.81 \pm 1.17	5.52 \pm 0.15	9.22 \pm 0.20	10.3 \pm 0.22	6.77 \pm 0.21	11.2 \pm 0.27	10.6 \pm 0.24
22-S-199	38	137	0-3.0	69.8	6.00 \pm 0.72	5.84 \pm 0.76	6.80 \pm 1.01	3.33 \pm 0.14	4.84 \pm 0.16	6.68 \pm 0.20	3.74 \pm 0.20	6.06 \pm 0.22	6.68 \pm 0.22
22-S-200	38	137	3.0-5.5	77.7	5.48 \pm 0.74	4.88 \pm 0.88	7.81 \pm 1.08	3.48 \pm 0.15	4.58 \pm 0.18	6.68 \pm 0.20	3.80 \pm 0.19	5.85 \pm 0.23	6.37 \pm 0.21
22-S-211	55	166	0-2.5	77.0	17.6 \pm 0.96	20.2 \pm 1.14	42.5 \pm 2.16	11.7 \pm 0.22	18.6 \pm 0.27	33.1 \pm 0.43	14.9 \pm 0.30	23.3 \pm 0.37	32.5 \pm 0.48
22-S-212	55	166	2.5-6.0	80.0	11.6 \pm 0.87	9.90 \pm 1.00	22.3 \pm 1.80	6.14 \pm 0.18	8.83 \pm 0.20	17.7 \pm 0.33	8.23 \pm 0.25	11.0 \pm 0.28	16.8 \pm 0.36
22-S-209	56	167	0-3.5	71.7	29.5 \pm 1.20	30.1 \pm 1.40	60.0 \pm 3.00	17.6 \pm 0.27	29.9 \pm 0.34	54.2 \pm 0.59	21.7 \pm 0.36	38.0 \pm 0.48	51.9 \pm 0.63
22-S-210	56	167	3.5-5.7	78.3	10.3 \pm 0.91	10.7 \pm 0.88	18.7 \pm 1.72	6.10 \pm 0.16	9.32 \pm 0.20	16.0 \pm 0.34	7.60 \pm 0.23	10.8 \pm 0.28	15.4 \pm 0.33
22-S-207	56	168	0-3.0	74.7	13.7 \pm 0.89	13.2 \pm 1.08	23.8 \pm 2.18	7.93 \pm 0.19	12.6 \pm 0.23	23.0 \pm 0.39	9.24 \pm 0.26	15.8 \pm 0.32	21.9 \pm 0.42
22-S-208	56	168	3.0-6.5	79.2	7.28 \pm 0.68	6.09 \pm 0.73	13.5 \pm 1.41	4.11 \pm 0.14	5.48 \pm 0.17	10.8 \pm 0.26	4.90 \pm 0.19	6.97 \pm 0.22	9.66 \pm 0.28
22-S-318	65	301	4	82.3	BDL	1.28 \pm 0.62	2.34 \pm 0.98	0.91 \pm 0.12	1.20 \pm 0.10	2.07 \pm 0.16	1.28 \pm 0.15	1.47 \pm 0.12	2.08 \pm 0.17
22-S-295	66	237	6-13.0	81.4	BDL	1.20 \pm 0.63	2.92 \pm 1.22	0.55 \pm 0.10	0.71 \pm 0.10	1.28 \pm 0.13	0.68 \pm 0.13	0.90 \pm 0.15	1.49 \pm 0.14
22-S-296	66	237	16	84.3	BDL	BDL	2.78 \pm 0.88	0.60 \pm 0.10	0.60 \pm 0.09	0.90 \pm 0.12	0.84 \pm 0.13	0.80 \pm 0.13	0.97 \pm 0.13

TABLE D.3 (Cont'd)

Sample No.	Reg. No.	Hole No.	Depth in.	Dry wt %	Ra-226 (186 keV)		Pb-214 (352 keV)		Bi-214 (609 keV)	
					--Initial--	--Aged--	--Initial--	--Aged--	--Initial--	--Aged--
					pCi/g \pm σ		pCi/g \pm σ		pCi/g \pm σ	
					--Dried--	--Dried--	--Dried--	--Dried--	--Dried--	--Dried--

TABLE D.4 Th-232 and K-40 Analyses of Soil Samples Collected Near Soil Tubes

Sample No.	Reg. No.	Hole No.	Depth in.	Dry Wt %	Th-232 (911 keV)			K-40 (1460 keV)		
					--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
					pCi/g $\pm \sigma$			pCi/g $\pm \sigma$		
Zone Number 1										
22-Z-434	3	701	0-6	96.9	1.55 \pm 0.34	2.07 \pm 0.31	1.51 \pm 0.34	15.3 \pm 1.8	18.3 \pm 2.0	12.9 \pm 1.5
22-S-435	3	701	12-18	88.2	1.08 \pm 0.21	0.84 \pm 0.22	1.58 \pm 0.26	19.0 \pm 1.4	20.8 \pm 1.3	18.0 \pm 1.4
22-S-436	3	701	18-20	86.1	1.51 \pm 0.24	1.33 \pm 0.24	1.52 \pm 0.25	17.9 \pm 1.4	15.1 \pm 1.4	15.5 \pm 1.4
22-Z-438	3	702	0-6	94.1	1.97 \pm 0.28	1.26 \pm 0.29	1.76 \pm 0.28	12.4 \pm 1.5	12.2 \pm 1.5	8.1 \pm 1.3
22-Z-439	3	702	12-14	88.9	1.15 \pm 0.20	1.17 \pm 0.23	1.15 \pm 0.25	17.4 \pm 1.3	21.2 \pm 1.3	16.1 \pm 1.3
22-Z-440	4	703	0-6	94.5	1.78 \pm 0.25	1.09 \pm 0.24	1.82 \pm 0.26	11.3 \pm 1.3	16.6 \pm 1.3	12.3 \pm 1.3
22-S-441	4	703	9-12	88.6	1.12 \pm 0.23	1.35 \pm 0.23	1.61 \pm 0.25	18.8 \pm 1.3	19.4 \pm 1.3	18.1 \pm 1.4
22-S-442	4	703	12-14	86.9	1.49 \pm 0.23	1.18 \pm 0.22	1.50 \pm 0.25	19.6 \pm 1.4	18.4 \pm 1.4	18.3 \pm 1.4
Zone Number 2										
22-S-279	99	332	0-3.5	88.4	2.00 \pm 0.45	2.06 \pm 0.46	1.70 \pm 0.45	36.4 \pm 2.6	36.4 \pm 2.7	23.2 \pm 1.9
22-S-280	99	332	3.5-6.5	91.8	1.50 \pm 0.36	2.49 \pm 0.38	1.93 \pm 0.28	51.8 \pm 2.7	41.2 \pm 2.6	33.9 \pm 1.6
22-S-281	99	332	6.5-8.5	90.5	2.22 \pm 0.42	2.39 \pm 0.45	1.93 \pm 0.40	50.3 \pm 2.7	46.7 \pm 2.7	35.0 \pm 1.9
22-S-284	99	334	0-3.3	89.3	2.17 \pm 0.28	1.94 \pm 0.30	2.45 \pm 0.29	36.2 \pm 2.2	38.0 \pm 2.1	30.2 \pm 1.6
22-S-285	99	334	3.3-6.0	86.9	1.69 \pm 0.32	1.84 \pm 0.32	2.11 \pm 0.29	40.6 \pm 2.3	30.7 \pm 2.1	25.3 \pm 1.6
22-S-286	99	334	6.0-7.5	84.5	1.09 \pm 0.24	1.97 \pm 0.37	2.18 \pm 0.33	17.0 \pm 1.6	32.4 \pm 2.5	28.0 \pm 1.8
22-S-287	100	335	0-3.5	88.3	2.21 \pm 0.64	BDL	1.77 \pm 0.49	40.1 \pm 3.4	39.3 \pm 3.4	27.4 \pm 2.0
22-S-288	100	335	3.5-6.0	92.9	2.40 \pm 0.33	1.78 \pm 0.31	1.79 \pm 0.24	49.9 \pm 2.5	51.5 \pm 2.5	31.6 \pm 1.5
22-S-302	100	661	0-3.7	87.7	2.12 \pm 0.35	1.83 \pm 0.34	1.68 \pm 0.32	45.8 \pm 2.3	38.5 \pm 2.3	28.3 \pm 1.6
22-S-303	100	661	3.7-6.0	89.6	1.48 \pm 0.38	1.84 \pm 0.44	1.09 \pm 0.31	57.3 \pm 3.0	56.5 \pm 3.0	39.5 \pm 2.1
22-S-278	103	330	0-4.0	79.6	1.82 \pm 0.43	1.18 \pm 0.55	1.23 \pm 0.48	29.5 \pm 2.4	23.6 \pm 2.8	18.9 \pm 2.1
22-S-321	104	347	17	80.8	1.53 \pm 0.31	1.37 \pm 0.25	0.88 \pm 0.23	58.9 \pm 2.3	37.3 \pm 1.5	35.5 \pm 1.3
22-S-299	104	347	18	93.6	1.57 \pm 0.28	1.61 \pm 0.25	1.07 \pm 0.21	28.5 \pm 1.8	26.5 \pm 1.7	18.0 \pm 1.1
22-S-301	104	347	24	93.5	1.67 \pm 0.26	1.26 \pm 0.27	0.92 \pm 0.19	35.3 \pm 2.0	31.2 \pm 1.9	22.7 \pm 1.2
22-S-300	104	347	30	88.0	2.65 \pm 0.29	2.31 \pm 0.33	3.87 \pm 0.14	18.0 \pm 1.6	18.3 \pm 1.7	16.3 \pm 0.5
22-S-300	104	347	30	88.5	2.65 \pm 0.29	2.31 \pm 0.33	3.08 \pm 0.28	18.0 \pm 1.6	18.3 \pm 1.7	13.2 \pm 1.2
22-S-298	104	347	36	90.6	5.63 \pm 0.41	5.85 \pm 0.42	6.52 \pm 0.14	18.4 \pm 1.9	14.8 \pm 1.7	11.5 \pm 0.5
22-S-298	104	347	36	89.9	5.63 \pm 0.41	5.85 \pm 0.42	5.22 \pm 0.35	18.4 \pm 1.9	14.8 \pm 1.7	9.8 \pm 1.1
22-S-216	105	329	0-3.5	86.3	BDL	2.00 \pm 0.56	1.34 \pm 0.54	24.5 \pm 2.3	20.2 \pm 2.7	14.1 \pm 2.0
22-S-217	105	329	3.5-5.5	87.2	1.51 \pm 0.60	BDL	BDL	33.1 \pm 3.0	28.8 \pm 3.5	23.7 \pm 2.3
22-S-213	106	328	0-3.0	75.1	1.46 \pm 0.40	1.64 \pm 0.38	1.01 \pm 0.41	30.2 \pm 2.7	26.5 \pm 2.6	25.9 \pm 2.1
22-S-214	106	328	3.0-5.2	83.5	1.31 \pm 0.30	0.76 \pm 0.25	1.16 \pm 0.25	33.3 \pm 2.2	28.5 \pm 2.1	22.9 \pm 1.5
22-S-215	107	344	0-24	90.3	1.17 \pm 0.32	1.24 \pm 0.29	1.12 \pm 0.22	41.2 \pm 2.6	40.3 \pm 2.4	26.6 \pm 1.6
22-S-282	108	333	0-4.5	84.1	2.02 \pm 0.30	1.46 \pm 0.28	1.44 \pm 0.26	37.9 \pm 2.2	37.9 \pm 2.1	27.9 \pm 1.6
22-S-283	108	333	4.5-7.0	77.7	1.30 \pm 0.26	1.04 \pm 0.23	1.42 \pm 0.25	25.0 \pm 1.8	21.0 \pm 1.6	18.8 \pm 1.4
22-S-270	109	323	0-3.0	90.6	1.51 \pm 0.31	0.80 \pm 0.32	0.85 \pm 0.22	35.0 \pm 2.3	28.2 \pm 2.1	21.3 \pm 1.3
22-S-271	109	323	3.0-6.0	91.7	2.62 \pm 0.33	2.33 \pm 0.33	1.91 \pm 0.25	51.5 \pm 2.5	45.3 \pm 2.4	33.5 \pm 1.6
22-S-212	109	323	6.0-9.5	90.6	1.94 \pm 0.36	1.99 \pm 0.31	2.21 \pm 0.28	53.0 \pm 2.6	45.8 \pm 2.4	34.4 \pm 1.6

TABLE D.4 (Cont'd)

Sample No.	Reg. No.	Hole No.	Depth in.	Dry Wt %	Th-232 (911 keV)			K-40 (1460 keV)			
					--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	
					pCi/g $\pm \sigma$			pCi/g $\pm \sigma$			
Zone Number 4											
22-S-187	81	194	0-2.8	74.1	1.01 \pm 0.29	1.24 \pm 0.40	0.70 \pm 0.26	20.7 \pm 1.8	22.2 \pm 2.1	11.9 \pm 1.2	
22-S-188	81	194	2.8-6.0	79.9	1.11 \pm 0.26	0.99 \pm 0.28	0.80 \pm 0.19	20.1 \pm 1.6	23.9 \pm 1.6	10.6 \pm 0.9	
22-S-191	81	195	0-2.5	75.1	1.65 \pm 0.33	1.36 \pm 0.35	0.82 \pm 0.22	22.3 \pm 2.1	26.3 \pm 2.2	12.8 \pm 0.9	
22-S-192	82	182	0-3.0	73.6	1.07 \pm 0.26	1.28 \pm 0.30	0.75 \pm 0.20	19.5 \pm 1.7	18.3 \pm 1.9	12.1 \pm 1.0	
22-S-193	82	182	3.0-5.8	80.8	1.82 \pm 0.23	1.13 \pm 0.24	0.77 \pm 0.16	21.7 \pm 1.6	24.3 \pm 1.7	12.6 \pm 0.9	
22-S-194	83	183	0-3.0	75.8	2.19 \pm 0.51	1.44 \pm 0.56	BDL	19.0 \pm 2.4	18.8 \pm 3.0	15.1 \pm 1.7	
22-S-189	83	191	0-2.5	74.6	1.06 \pm 0.36	0.90 \pm 0.42	0.59 \pm 0.28	21.2 \pm 2.1	21.2 \pm 2.3	13.5 \pm 1.3	
22-S-190	83	191	2.5-5.5	80.5	0.71 \pm 0.33	1.05 \pm 0.34	1.14 \pm 0.27	24.1 \pm 2.0	26.4 \pm 2.0	14.3 \pm 1.2	
22-S-195	85	179	0-3.5	75.8	1.04 \pm 0.26	1.53 \pm 0.34	1.32 \pm 0.23	17.6 \pm 1.7	20.1 \pm 1.8	9.8 \pm 1.1	
22-S-196	85	180	0-3.5	72.9	0.97 \pm 0.29	1.19 \pm 0.33	0.93 \pm 0.25	21.0 \pm 1.8	20.4 \pm 2.0	11.8 \pm 1.1	
Zone Number 5											
22-S-291	71	341	0-4.0	91.8	2.55 \pm 0.33	2.45 \pm 0.34	2.33 \pm 0.26	55.1 \pm 2.7	49.6 \pm 2.8	39.1 \pm 1.8	
22-S-292	71	341	4.0-7.2	90.7	1.73 \pm 0.36	2.02 \pm 0.35	2.27 \pm 0.33	44.1 \pm 2.6	47.6 \pm 2.6	34.3 \pm 1.7	
22-S-293	71	341	7.2-9.0	91.3	1.29 \pm 0.36	1.20 \pm 0.32	1.83 \pm 0.27	43.6 \pm 2.4	37.9 \pm 2.3	27.5 \pm 1.5	
22-S-294	71	341	9.0-12.3	90.6	1.96 \pm 0.31	1.23 \pm 0.35	1.30 \pm 0.26	40.0 \pm 2.4	28.1 \pm 2.2	26.6 \pm 1.5	
22-S-289	96	339	0-5.5	85.2	1.53 \pm 0.39	1.20 \pm 0.46	1.55 \pm 0.41	26.4 \pm 2.3	21.3 \pm 2.4	15.5 \pm 1.8	
22-S-290	96	339	5.5-8.0	90.9	2.18 \pm 0.31	1.86 \pm 0.30	1.50 \pm 0.26	30.7 \pm 2.3	32.4 \pm 2.1	22.9 \pm 1.5	
Zone Number 6											
22-S-197	38	136	0-4.0	70.8	1.17 \pm 0.30	0.79 \pm 0.28	0.96 \pm 0.32	23.0 \pm 1.8	18.6 \pm 2.0	16.4 \pm 1.4	
22-S-198	38	136	4.0-6.0	74.5	0.93 \pm 0.29	0.79 \pm 0.31	0.57 \pm 0.25	15.7 \pm 1.7	17.9 \pm 1.9	10.3 \pm 1.0	
22-S-199	38	137	0-3.0	69.8	BDL	1.35 \pm 0.33	0.75 \pm 0.23	18.4 \pm 2.0	20.5 \pm 2.0	10.3 \pm 1.1	
22-S-200	38	137	3.0-5.5	77.7	1.09 \pm 0.32	1.40 \pm 0.37	0.84 \pm 0.25	22.4 \pm 2.0	22.6 \pm 2.0	15.2 \pm 1.1	
22-S-211	55	166	0-2.5	77.0	1.31 \pm 0.35	2.23 \pm 0.40	2.05 \pm 0.42	16.8 \pm 2.0	17.7 \pm 2.2	12.3 \pm 1.7	
22-S-212	55	166	2.5-6.0	80.0	1.74 \pm 0.33	1.57 \pm 0.34	1.39 \pm 0.33	17.1 \pm 2.0	23.6 \pm 2.1	16.0 \pm 1.5	
22-S-209	56	167	0-3.5	71.7	1.33 \pm 0.37	1.95 \pm 0.45	1.44 \pm 0.54	17.2 \pm 2.0	11.3 \pm 2.3	13.7 \pm 2.0	
22-S-210	56	167	3.5-5.7	78.3	1.34 \pm 0.29	1.13 \pm 0.36	1.77 \pm 0.34	17.6 \pm 1.9	20.8 \pm 1.9	16.4 \pm 1.4	
22-S-207	56	168	0-3.0	74.7	1.62 \pm 0.34	1.86 \pm 0.37	1.44 \pm 0.37	14.3 \pm 1.9	18.0 \pm 1.9	13.0 \pm 1.5	
22-S-208	56	168	3.0-6.5	79.2	1.41 \pm 0.33	1.24 \pm 0.33	1.53 \pm 0.27	17.4 \pm 1.8	17.8 \pm 1.8	14.1 \pm 1.3	
22-S-218	65	301	4	82.3	1.19 \pm 0.32	1.60 \pm 0.21	1.27 \pm 0.27	18.5 \pm 2.0	13.8 \pm 1.3	16.8 \pm 1.5	
22-S-295	66	237	6-13.0	81.4	1.04 \pm 0.31	1.06 \pm 0.29	1.63 \pm 0.27	21.3 \pm 2.0	20.7 \pm 1.9	15.3 \pm 1.4	
22-S-296	66	237	16	84.3	1.12 \pm 0.28	0.77 \pm 0.26	0.87 \pm 0.24	21.5 \pm 1.8	19.7 \pm 1.8	10.9 \pm 1.2	

TABLE D.4 (Cont'd)

Sample No.	Reg. No.	Hole No.	Depth in.	Dry Wt %	Th-232 (911 keV)			K-40 (1460 keV)		
					--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
					pCi/g \pm σ			pCi/g \pm σ		
Zone Number 8										
22-S-179	28	506	0-2.5	67.0	0.97 \pm 0.40	1.18 \pm 0.39	0.82 \pm 0.29	16.6 \pm 2.3	14.4 \pm 2.2	9.5 \pm 1.3
22-S-180	28	506	2.5-5.0	76.0	0.68 \pm 0.33	1.12 \pm 0.31	0.94 \pm 0.23	14.5 \pm 1.7	17.8 \pm 2.0	10.8 \pm 1.0
22-S-181	28	506	5.0-7.3	78.2	1.39 \pm 0.26	1.13 \pm 0.25	0.97 \pm 0.25	18.4 \pm 1.6	19.1 \pm 1.6	13.5 \pm 1.2
22-S-174	28	507	0-3.0	62.8	0.88 \pm 0.31	1.26 \pm 0.34	0.88 \pm 0.26	13.1 \pm 1.9	17.8 \pm 1.9	9.3 \pm 1.1
22-S-175	28	507	3.0-6.0	75.7	1.29 \pm 0.27	0.73 \pm 0.31	1.03 \pm 0.26	18.1 \pm 1.8	16.9 \pm 2.0	11.6 \pm 1.1
22-S-176	33	523	0-2.5	42.9	BDL	BDL	0.57 \pm 0.33	8.3 \pm 2.6	11.7 \pm 2.8	46.4 \pm 1.5
22-S-177	33	523	2.5-5.7	71.1	1.78 \pm 0.41	1.23 \pm 0.40	BDL	16.6 \pm 2.1	17.9 \pm 2.3	9.5 \pm 1.4
22-S-178	33	523	5.7-7.3	75.4	1.76 \pm 0.33	0.80 \pm 0.35	1.41 \pm 0.30	18.2 \pm 1.9	21.0 \pm 2.0	11.3 \pm 1.1
22-S-183	34	518	0-3.0	70.2	0.79 \pm 0.28	0.86 \pm 0.28	0.80 \pm 0.18	22.4 \pm 1.8	21.7 \pm 1.9	10.7 \pm 1.0
22-S-184	34	518	3.0-5.5	81.5	1.16 \pm 0.26	1.19 \pm 0.24	1.09 \pm 0.15	26.6 \pm 1.6	23.0 \pm 1.6	11.2 \pm 0.8
22-S-182	34	521	0-2.5	62.3	1.28 \pm 0.31	0.84 \pm 0.32	1.31 \pm 0.37	15.6 \pm 2.0	16.1 \pm 2.1	12.5 \pm 1.9
22-S-213	34	521	2.5-6.3	73.6	1.20 \pm 0.25	1.49 \pm 0.27	1.20 \pm 0.26	21.1 \pm 1.7	19.5 \pm 1.7	17.0 \pm 1.3
22-S-203	35	140	0-3.5	65.3	0.72 \pm 0.40	1.56 \pm 0.46	BDL	14.3 \pm 2.2	14.8 \pm 2.3	13.1 \pm 1.8
22-S-204	35	140	3.5-6.0	75.1	0.95 \pm 0.38	1.81 \pm 0.43	BDL	23.6 \pm 2.1	18.1 \pm 2.4	17.9 \pm 1.8
22-S-205	35	141	0-2.5	60.4	BDL	0.80 \pm 0.39	2.10 \pm 0.40	15.7 \pm 2.2	15.9 \pm 2.3	12.8 \pm 2.2
22-S-206	35	141	2.5-5.5	70.9	0.65 \pm 0.28	0.63 \pm 0.29	1.33 \pm 0.41	13.7 \pm 1.9	16.2 \pm 1.9	15.1 \pm 1.9
22-S-201	36	138	0-3.7	70.5	1.31 \pm 0.38	1.31 \pm 0.49	1.16 \pm 0.56	18.3 \pm 2.2	19.3 \pm 2.4	13.2 \pm 1.9
22-S-202	36	138	3.7-8.0	78.5	1.13 \pm 0.27	1.40 \pm 0.31	1.13 \pm 0.29	26.4 \pm 1.8	22.8 \pm 1.9	17.0 \pm 1.5
22-S-185	36	517	0-3.0	60.9	1.20 \pm 0.31	1.25 \pm 0.39	1.06 \pm 0.29	14.7 \pm 2.2	13.9 \pm 2.4	7.1 \pm 1.2
22-S-186	36	517	3.0-5.5	75.4	1.43 \pm 0.30	1.36 \pm 0.34	0.58 \pm 0.23	20.4 \pm 1.9	21.2 \pm 1.9	13.0 \pm 1.0
22-S-240	37	515	0-3.0	74.2	1.17 \pm 0.29	1.45 \pm 0.33	1.18 \pm 0.26	21.7 \pm 1.9	23.0 \pm 2.0	15.6 \pm 1.5
22-S-241	37	515	3.0-6.0	83.4	1.45 \pm 0.23	1.35 \pm 0.23	1.13 \pm 0.21	26.4 \pm 1.6	26.7 \pm 1.6	21.4 \pm 1.3
22-S-242	37	516	0-3.0	66.6	1.23 \pm 0.30	0.87 \pm 0.38	1.68 \pm 0.36	22.2 \pm 2.0	17.4 \pm 2.0	13.5 \pm 1.7
22-S-243	37	516	3.0-6.0	77.3	1.18 \pm 0.26	1.37 \pm 0.30	1.96 \pm 0.27	20.3 \pm 1.8	24.2 \pm 1.8	17.9 \pm 1.4
Ave.			80.6	1.57	1.51	1.51	1.50	25.6	24.6	18.3
Std. dev.			9.6	0.78	0.81	0.81	0.89	11.9	10.0	8.2
Max			96.9	5.63	5.85	5.85	6.52	58.9	56.5	40.4
Min			42.9	0.65	0.63	0.63	0.57	8.3	11.3	7.1
No. of Samples			89	85	86	86	84	89	89	89

*Samples dried and analyzed by th ACL.
 oUncertainty in the counting statistics.
 NA = Data Not Available.
 BDL = Below Detectable Level.

TABLE D.5 Ra-226 Analyses of Soil Samples Collected at Test Plot

Sample No.	Coordinates			Dry Wt %	Ra-226 (186 keV)			Pb-214 (352 keV)			Bi-214 (609 keV)		
	X	Y	Z		--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
pCi/g ± σ													
105/107 Stratford Avenue													
22-S-086	43.5L	0+03.0	-4.3	85.8	10.0 ±0.65	10.5 ±0.90	15.9 ±1.75	6.02±0.14	8.04±0.20	14.3 ±0.32	7.23±0.18	10.0 ±0.27	14.0 ±0.34
22-S-087	43.5L	0+18.0	-5.0	88.0	2.29±0.27	4.36±0.74	3.99±1.00	1.15±0.05	1.24±0.11	2.34±0.15	1.67±0.07	1.53±0.15	2.44±0.16
22-S-251	44.5L	0+11.0	-3.0	86.8	4.52±0.70	6.63±0.80	9.04±1.15	1.85±0.14	3.13±0.16	6.74±0.22	2.69±0.18	4.60±0.22	6.12±0.24
22-S-088	48.5L	0+08.0	-5.0	81.9	6.32±0.90	4.37±0.86	12.6 ±1.54	3.78±0.18	4.49±0.17	8.29±0.25	5.02±0.25	5.49±0.22	8.29±0.28
22-S-089	48.5L	0+13.0	-6.1	86.8	12.4 ±1.50	10.4 ±1.01	14.1 ±1.67	8.12±0.29	6.91±0.21	10.2 ±0.30	10.3 ±0.38	9.04±0.29	10.4 ±0.31
22-S-100	48.5L	0+15.0	-5.0	89.1	2.39±0.57	2.17±0.85	2.23±0.96	0.79±0.09	0.78±0.13	1.08±0.17	1.00±0.12	0.76±0.18	1.38±0.17
22-S-090	48.5L	0+18.0	-6.1	87.3	9.75±1.55	8.86±0.89	12.5 ±1.39	5.69±0.30	6.89±0.20	8.11±0.26	6.29±0.40	8.23±0.28	7.38±0.27
22-S-250	48.5L	0+19.5	-4.6	79.8	4.05±0.86	5.35±0.84	8.99±1.57	2.23±0.14	2.79±0.15	6.03±0.24	2.60±0.20	3.27±0.21	5.48±0.25
22-S-091	48.5L	0+20.0	-6.0	88.4	6.44±0.16	6.33±0.84	10.1 ±1.52	3.66±0.04	4.36±0.17	7.69±0.26	4.54±0.05	5.36±0.23	7.60±0.26
22-S-139	51.5L	0+05.0	0.0	81.2	3.25±0.61	3.03±0.69	5.28±0.71	2.15±0.10	2.53±0.11	3.06±0.12	2.58±0.13	3.12±0.15	3.19±0.14
22-S-094	53.5L	0+05.0	-5.1	82.6	1.65±0.46	BDL	3.33±0.89	0.96±0.09	0.76±0.10	1.60±0.14	1.34±0.12	1.13±0.13	1.35±0.14
22-S-141	54.5L	0+19.0	-6.5	90.2	2.31±0.75	BDL	3.52±0.94	1.46±0.13	1.20±0.12	1.65±0.15	1.79±0.19	1.69±0.16	1.55±0.14
22-S-095	56.5L	0+11.0	-6.5	88.9	1.40±0.39	1.36±0.57	BDL	0.96±0.08	0.70±0.11	0.81±0.13	1.36±0.11	0.57±0.13	0.92±0.14
22-S-113	57.5L	0+13.0	-5.5	86.6	34.2 ±1.52	33.7 ±1.60	49.9 ±2.59	23.6 ±0.34	31.3 ±0.39	40.2 ±0.47	29.0 ±0.48	39.6 ±0.52	38.3 ±0.51
22-S-099	58.5L	0+08.0	-6.0	90.0	3.73±0.62	2.59±0.78	3.15±0.99	1.76±0.10	2.52±0.15	2.85±0.20	2.09±0.15	2.41±0.20	3.02±0.21
22-S-096	58.5L	0+15.0	-4.2	84.8	20 ±1.66	19.3 ±1.24	29.6 ±1.83	11.2 ±0.33	16.8 ±0.28	22.2 ±0.40	14.6 ±0.45	21.1 ±0.40	20.4 ±0.42
22-S-092	58.5L	0+18.0	-2.2	84.3	11.9 ±1.18	12.3 ±0.96	17.8 ±1.67	12.4 ±0.25	8.89±0.21	15.3 ±0.33	17.2 ±0.36	10.5 ±0.28	15.0 ±0.35
22-S-093	58.5L	0+18.0	-4.0	87.3	5.24±0.54	3.50±0.70	5.30±1.22	3.74±0.09	2.69±0.13	4.53±0.19	6.87±0.14	3.83±0.18	4.35±0.21
22-S-098	58.5L	0+18.0	-6.5	90.7	10.7 ±1.05	13.7 ±1.25	21.7 ±1.79	8.65±0.23	12.6 ±0.27	15.6 ±0.36	10.8 ±0.32	16.1 ±0.36	15.2 ±0.38
22-S-116	61.5L	0+13.0	-5.5	83.7	2.38±0.57	2.24±0.57	BDL	0.90±0.10	0.87±0.09	1.26±0.11	0.93±0.12	0.89±0.12	1.21±0.12
22-S-107	61.5L	0+15.0	-5.5	85.8	5.37±0.73	4.30±0.68	8.27±1.21	3.03±0.13	3.24±0.13	5.75±0.20	4.25±0.18	4.10±0.17	5.49±0.21
22-S-097	62.5L	0+03.0	-2.2	84.1	7.55±1.11	6.85±0.84	11.9 ±1.31	9.62±0.25	5.97±0.17	10.5 ±0.27	13.1 ±0.34	7.26±0.24	9.99±0.29
22-S-108	62.5L	0+19.0	-5.0	86.8	BDL	BDL	BDL	0.44±0.07	0.25±0.08	0.38±0.09	0.73±0.10	0.42±0.10	0.52±0.10
22-S-110	63.5L	0+03.0	-1.5	82.2	8.04±0.26	6.47±0.71	8.56±0.96	3.80±0.05	4.12±0.14	6.64±0.19	4.89±0.07	5.13±0.19	6.78±0.20
22-S-109	63.5L	0+03.0	-3.0	84.9	2.71±0.34	3.86±0.62	3.65±0.91	1.14±0.05	1.99±0.11	2.20±0.13	1.58±0.07	2.54±0.15	2.11±0.13
22-S-114	63.5L	0+13.0	-6.0	83.1	2.61±0.61	2.02±0.78	3.92±1.24	1.21±0.11	1.18±0.10	2.56±0.17	1.44±0.15	1.55±0.14	2.67±0.19
22-S-115	63.5L	0+13.0	-5.5	82.9	7.61±0.79	6.72±0.86	9.75±1.11	4.12±0.16	5.45±0.17	6.56±0.20	5.83±0.22	6.58±0.23	6.26±0.21
22-S-111	70.5L	0+15.0	-5.0	82.9	47.4 ±2.25	49.8 ±2.10	79.5 ±2.98	33.3 ±0.53	43.7 ±0.45	55.8 ±0.55	45.0 ±0.76	56.4 ±0.64	55.1 ±0.59
22-S-252	73.5L	0+19.5	-6.5	86.6	2.51±0.83	2.80±0.67	4.18±1.06	1.40±0.11	1.65±0.12	3.64±0.17	1.80±0.16	2.05±0.16	3.44±0.19
22-S-253	75.5L	0+22.5	-8.1	84.8	18.4 ±1.17	16.3 ±1.31	37.6 ±2.35	11.5 ±0.26	11.2 ±0.25	29.4 ±0.45	14.1 ±0.34	15.0 ±0.35	29.0 ±0.49
22-S-112	76.5L	0+21.0	-3.5	84.5	3.54±0.65	2.91±0.79	5.21±1.04	1.99±0.10	2.32±0.14	3.02±0.16	3.24±0.15	3.23±0.19	2.90±0.17
22-S-136	81.5L	0+23.0	-2.0	83.5	8.33±0.76	9.99±0.75	11.10±1.22	4.11±0.14	7.09±0.17	7.47±0.20	5.13±0.19	8.52±0.23	7.84±0.21
22-S-030	83.5L	0+23.0	-0.3	70.6	35.0 ±0.22	37.0 ±1.37	67.1 ±2.69	18.2 ±0.05	31.2 ±0.35	28.7 ±0.48	22.5 ±0.07	39.8 ±0.49	31.1 ±0.52
22-S-031	83.5L	0+23.0	-0.7	77.7	55.2 ±0.76	54.4 ±1.63	85.5 ±2.76	32.9 ±0.17	45.7 ±0.41	48.6 ±0.54	40.4 ±0.23	56.3 ±0.56	47.1 ±0.57

TABLE D.5 (Cont'd)

Sample No.	Coordinates		Dry Wt %	Ra-226 (186 keV)		Pb-214 (352 keV)		Bi-214 (609 keV)		
	X	Y		--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	
				pCi/g $\pm \sigma$		pCi/g $\pm \sigma$		pCi/g $\pm \sigma$		
22-S-034	83.5L	0+23.0	-0.9	78.7	42.8 \pm 0.82	43.2 \pm 1.57	68.4 \pm 2.44	25.1 \pm 0.19	38.0 \pm 0.37	38.4 \pm 0.48
22-S-035	83.5L	0+23.0	-1.1	81.5	13.4 \pm 0.50	13.7 \pm 0.81	22.3 \pm 1.51	7.93 \pm 0.10	11.3 \pm 0.20	13.0 \pm 0.27
*22-S-036	83.5L	0+23.0	-1.4	81.3	10.8 \pm 0.52	NA	NA	6.01 \pm 0.09	NA	30.03 \pm 0.33
*22-S-036	83.5L	0+23.0	-1.4	81.3	10.8 \pm 0.52	NA	NA	7.42 \pm 0.13	NA	29.41 \pm 0.24
*22-S-039	83.5L	0+23.0	-1.7	84.1	7.18 \pm 0.46	NA	NA	4.49 \pm 0.09	NA	9.45 \pm 0.17
*22-S-039	83.5L	0+23.0	-1.7	84.1	7.18 \pm 0.46	NA	NA	4.49 \pm 0.09	NA	9.84 \pm 0.15
22-S-037	83.5L	0+23.0	-2.0	88.1	3.59 \pm 0.35	5.29 \pm 0.63	7.26 \pm 0.97	2.13 \pm 0.07	3.02 \pm 0.12	3.25 \pm 0.15
22-S-038	83.5L	0+23.0	-2.0	87.9	5.00 \pm 0.47	4.31 \pm 0.71	9.08 \pm 1.11	2.84 \pm 0.10	4.23 \pm 0.15	5.63 \pm 0.20
22-S-135	84.5L	0+18.0	-2.0	86.7	2.55 \pm 0.56	1.92 \pm 0.56	3.85 \pm 0.83	1.09 \pm 0.09	1.11 \pm 0.09	1.68 \pm 0.11
22-S-137	84.5L	0+22.0	-2.0	86.4	20.8 \pm 1.01	25.3 \pm 1.58	13.2 \pm 0.23	17.6 \pm 0.26	23.8 \pm 0.32	16.3 \pm 0.32
22-S-133	85.5L	0+07.0	-3.0	86.1	5.67 \pm 1.04	3.95 \pm 1.01	8.09 \pm 1.26	2.58 \pm 0.17	3.78 \pm 0.17	5.33 \pm 0.22
22-S-134	85.5L	0+09.0	-3.5	85.9	6.48 \pm 0.73	5.81 \pm 0.77	9.05 \pm 1.06	3.08 \pm 0.14	3.61 \pm 0.14	5.64 \pm 0.19
22-S-032	93.5L	0+13.0	0.0	69.2	6.15 \pm 0.34	6.92 \pm 0.70	15.1 \pm 1.47	4.51 \pm 0.07	5.74 \pm 0.16	6.88 \pm 0.26
*22-S-033	93.5L	0+13.0	-0.1	81.1	7.01 \pm 0.27	NA	NA	5.60 \pm 0.06	NA	14.52 \pm 0.16
*22-S-033	93.5L	0+13.0	-0.1	81.1	7.01 \pm 0.27	NA	NA	5.60 \pm 0.06	NA	10.2 \pm 0.13
22-S-140	101.5L	0+05.0	-2.5	82.6	2.16 \pm 0.44	1.90 \pm 0.50	2.49 \pm 0.66	0.86 \pm 0.08	1.43 \pm 0.09	1.63 \pm 0.10
112 Stewart Avenue										
22-S-131	23.0L	0- 6.0	-0.5	77.3	4.59 \pm 0.85	3.40 \pm 0.72	4.98 \pm 0.94	2.61 \pm 0.16	3.32 \pm 0.15	4.44 \pm 0.18
22-S-129	41.0L	0-19.0	-0.5	79.1	42.0 \pm 2.08	44.0 \pm 2.01	57.7 \pm 2.90	33.7 \pm 0.47	42.6 \pm 0.50	45.2 \pm 0.56
22-S-130	41.0L	0-19.0	-1.0	81.3	5.63 \pm 0.98	6.47 \pm 0.84	7.57 \pm 1.11	3.42 \pm 0.16	4.16 \pm 0.17	6.01 \pm 0.21
22-S-127	43.2L	0-05.0	-0.5	79.4	10.9 \pm 0.94	11.0 \pm 1.07	17.5 \pm 1.41	6.92 \pm 0.20	9.14 \pm 0.22	12.1 \pm 0.27
22-S-128	47.0L	0-06.0	-0.8	82.4	5.62 \pm 0.93	4.21 \pm 0.68	9.36 \pm 1.07	3.23 \pm 0.15	3.86 \pm 0.15	5.26 \pm 0.19
60 Union Street; Holes 38 and 39 in Region 27, Zone 8.										
22-S-044	157.0L	0-06.5	-0.3	73.0	9.18 \pm 0.64	6.90 \pm 0.95	14.9 \pm 1.28	5.89 \pm 0.13	5.72 \pm 0.18	10.1 \pm 0.24
22-S-045	157.0L	0-06.5	-0.5	73.8	22.3 \pm 0.99	22.5 \pm 1.13	33.5 \pm 1.92	13.6 \pm 0.20	14.4 \pm 0.25	27.9 \pm 0.37
22-S-046	157.0L	0-06.5	-0.8	79.0	12.4 \pm 0.77	12.1 \pm 0.82	18.9 \pm 1.46	7.29 \pm 0.16	8.21 \pm 0.19	16.5 \pm 0.27
22-S-047	157.0L	0-06.5	-1.0	78.6	4.35 \pm 0.54	3.35 \pm 0.62	7.73 \pm 0.96	3.12 \pm 0.10	4.34 \pm 0.13	6.06 \pm 0.16
22-S-040	157.0L	0-14.5	-0.3	78.7	3.90 \pm 0.58	3.68 \pm 0.62	4.32 \pm 1.01	1.85 \pm 0.10	2.30 \pm 0.12	4.23 \pm 0.18
22-S-041	157.0L	0-14.5	-0.5	81.3	2.41 \pm 0.10	2.98 \pm 0.58	3.78 \pm 1.16	1.33 \pm 0.02	1.86 \pm 0.10	2.93 \pm 0.15
22-S-042	157.0L	0-14.5	-0.8	79.7	1.39 \pm 0.35	2.11 \pm 0.50	2.89 \pm 0.68	1.05 \pm 0.06	0.84 \pm 0.09	1.64 \pm 0.10
22-S-043	157.0L	0-14.5	-1.0	81.0	1.37 \pm 0.22	1.18 \pm 0.46	1.19 \pm 0.61	0.99 \pm 0.04	0.57 \pm 0.08	1.25 \pm 0.09
99 Stratford Avenue										
22-S-126	4.5R	0+51.7	-0.3	81.2	6.76 \pm 0.88	6.26 \pm 0.94	9.71 \pm 1.27	3.69 \pm 0.16	5.66 \pm 0.18	7.75 \pm 0.23
								4.74 \pm 0.24	7.16 \pm 0.25	7.37 \pm 0.24

TABLE D.5 (Cont'd)

Sample: No.	Coordinates X Y Z		Dry Wt %	Ra-226 (186 keV)			Pb-214 (352 keV)			Bi-214 (609 keV)		
				--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
				pCi/g $\pm \sigma$	pCi/g $\pm \sigma$	pCi/g $\pm \sigma$	pCi/g $\pm \sigma$	pCi/g $\pm \sigma$	pCi/g $\pm \sigma$	pCi/g $\pm \sigma$	pCi/g $\pm \sigma$	pCi/g $\pm \sigma$
115 Stratford Avenue												
22-S-117	168.8L	0+02.0	-0.3	63.6	5.59 \pm 1.35	6.11 \pm 0.14	9.11 \pm 1.76	3.71 \pm 0.25	6.18 \pm 0.29	7.37 \pm 0.32	4.22 \pm 0.33	7.52 \pm 0.39
22-S-118	168.8L	0+02.0	-0.6	68.3	10.3 \pm 1.20	10.1 \pm 1.20	18.0 \pm 1.70	6.02 \pm 0.23	10.2 \pm 0.27	10.8 \pm 0.30	6.71 \pm 0.31	12.5 \pm 0.37
22-S-119	168.8L	0+02.0	-0.9	90.9	9.32 \pm 1.03	10.4 \pm 1.09	13.9 \pm 1.44	4.79 \pm 0.21	5.85 \pm 0.22	9.36 \pm 0.28	5.91 \pm 0.28	7.24 \pm 0.29
22-S-120	168.8L	0+02.0	-1.2	93.1	3.78 \pm 0.65	3.69 \pm 0.83	7.35 \pm 1.03	1.92 \pm 0.14	3.83 \pm 0.16	4.27 \pm 0.64	2.82 \pm 0.19	4.86 \pm 0.21
22-S-121	168.8L	0+02.0	-1.5	93.5	3.53 \pm 0.86	BDL	3.61 \pm 0.76	0.90 \pm 0.11	1.05 \pm 0.11	2.03 \pm 0.14	1.12 \pm 0.14	1.36 \pm 0.14
22-S-122	203.0L	0+04.0	-0.3	88.4	6.11 \pm 0.84	5.61 \pm 0.77	11.3 \pm 1.09	3.21 \pm 0.16	5.37 \pm 0.18	6.91 \pm 0.21	3.94 \pm 0.21	6.76 \pm 0.24
22-S-123	203.0L	0+04.0	-0.5	90.3	7.16 \pm 0.80	5.84 \pm 0.69	10.2 \pm 1.07	2.74 \pm 0.14	3.63 \pm 0.15	5.11 \pm 0.18	3.51 \pm 0.19	4.64 \pm 0.19
22-S-124	203.0L	0+04.0	-0.8	81.9	2.46 \pm 0.64	1.41 \pm 0.55	2.88 \pm 0.89	1.32 \pm 0.11	1.79 \pm 0.10	1.74 \pm 0.11	1.32 \pm 0.14	1.98 \pm 0.14
22-S-125	203.0L	0+04.0	-1.0	83.0	0.99 \pm 0.47	BDL	2.63 \pm 0.58	0.84 \pm 0.09	0.54 \pm 0.09	1.31 \pm 0.10	1.01 \pm 0.11	1.42 \pm 0.11
Ave				83.1	9.72	10.20	15.77	5.99	7.76	10.88	7.56	9.75
Std Dev				5.5	11.13	12.08	18.74	7.41	10.54	12.06	9.38	13.40
Max				93.5	55.20	54.40	85.50	33.70	45.14	55.80	43.70	56.40
Min				63.6	0.99	1.18	1.19	0.44	0.25	0.38	0.73	0.42
No of Samples				73	72	62	64	73	67	73	73	73

*Samples dried and analyzed by the ACL.

Uncertainty in the counting statistics.

NA = Data Not Available; ACL does not report the 186 keV activity.

BDL = Below Detectable Level.

TABLE D.6 Th-232 and K-40 Analyses of Soil Samples Collected at Test Plot

Sample No.	Coordinates			Dry Wt %	Th-232 (911 keV) pCi/g \pm σ			K-40 (1460 keV) pCi/g \pm σ		
	X	Y	Z		--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
105/107 Stratford Avenue										
22-S-086	43.5L	0+03.0	-4.3	85.8	1.95 \pm 0.29	2.06 \pm 0.36	1.02 \pm 0.37	34.3 \pm 1.7	30.2 \pm 2.3	25.5 \pm 1.8
22-S-087	43.5L	0+18.0	-5.0	88.0	2.07 \pm 0.15	1.52 \pm 0.33	1.58 \pm 0.27	46.1 \pm 1.1	46.8 \pm 2.4	31.5 \pm 1.6
22-S-251	44.5L	0+11.0	-3.0	86.8	1.13 \pm 0.34	1.17 \pm 0.38	1.56 \pm 0.27	21.4 \pm 2.6	46.1 \pm 2.6	33.3 \pm 1.8
22-S-088	48.5L	0+08.0	-5.0	81.9	2.24 \pm 0.37	1.33 \pm 0.31	1.50 \pm 0.32	21.4 \pm 2.4	28.0 \pm 2.0	18.8 \pm 1.6
22-S-089	48.5L	0+13.0	-6.1	86.8	0.80 \pm 0.47	1.36 \pm 0.35	1.51 \pm 0.36	28.8 \pm 3.0	29.1 \pm 2.5	16.7 \pm 1.7
22-S-100	48.5L	0+15.0	-5.0	89.1	1.39 \pm 0.26	1.61 \pm 0.30	1.01 \pm 0.30	17.2 \pm 1.7	17.8 \pm 2.2	10.3 \pm 1.4
22-S-090	48.5L	0+18.0	-6.1	87.3	1.25 \pm 0.53	0.70 \pm 0.40	1.06 \pm 0.35	33.7 \pm 4.0	35.1 \pm 2.4	24.1 \pm 1.7
22-S-250	48.5L	0+19.5	-4.6	79.8	1.39 \pm 0.35	1.83 \pm 0.35	1.84 \pm 0.29	33.7 \pm 2.5	34.7 \pm 2.6	23.3 \pm 1.7
22-S-091	48.5L	0+20.0	-6.0	88.4	1.39 \pm 0.09	1.34 \pm 0.35	1.44 \pm 0.28	22.0 \pm 0.6	17.2 \pm 2.2	15.8 \pm 1.6
22-S-139	51.5L	0+05.0	0.0	81.2	1.58 \pm 0.25	1.77 \pm 0.23	1.02 \pm 0.20	19.9 \pm 1.6	18.3 \pm 1.6	9.6 \pm 0.9
22-S-094	53.5L	0+05.0	-5.1	82.6	1.05 \pm 0.25	1.28 \pm 0.28	1.49 \pm 0.25	21.1 \pm 1.7	19.0 \pm 1.9	18.0 \pm 1.4
22-S-141	54.5L	0+1.0	-6.5	90.2	1.25 \pm 0.33	1.69 \pm 0.33	0.73 \pm 0.26	23.9 \pm 2.5	27.0 \pm 2.2	14.5 \pm 1.3
22-S-095	56.5L	0+11.0	-6.5	88.9	1.96 \pm 0.26	2.24 \pm 0.37	2.02 \pm 0.30	51.2 \pm 1.8	50.1 \pm 2.6	34.4 \pm 1.8
22-S-113	57.5L	0+13.0	-5.5	86.6	1.32 \pm 0.54	1.74 \pm 0.54	2.04 \pm 0.40	42.8 \pm 3.0	39.9 \pm 3.0	23.3 \pm 1.9
22-S-099	58.5L	0+08.0	-6.0	90.0	2.45 \pm 0.28	3.04 \pm 0.40	2.14 \pm 0.34	52.2 \pm 2.1	52.1 \pm 2.9	42.7 \pm 2.1
22-S-096	58.5L	0+15.0	-4.2	84.8	1.74 \pm 0.58	1.60 \pm 0.41	1.42 \pm 0.37	56.5 \pm 3.8	52.1 \pm 2.8	36.3 \pm 2.0
22-S-092	58.5L	0+18.0	-2.2	84.3	1.45 \pm 0.45	1.38 \pm 0.36	1.96 \pm 0.37	26.7 \pm 2.4	22.6 \pm 2.1	16.7 \pm 1.5
22-S-093	58.5L	0+18.0	-4.0	87.3	1.79 \pm 0.22	1.49 \pm 0.31	1.39 \pm 0.27	51.9 \pm 1.5	53.2 \pm 2.4	39.4 \pm 1.8
22-S-098	58.5L	0+18.0	-6.5	90.7	1.47 \pm 0.44	2.32 \pm 0.45	2.26 \pm 0.41	46.1 \pm 3.1	48.5 \pm 2.9	32.9 \pm 2.0
22-S-116	61.5L	0+13.0	-3.5	83.7	2.03 \pm 0.27	1.54 \pm 0.28	1.04 \pm 0.19	22.1 \pm 1.9	22.4 \pm 1.8	13.7 \pm 1.0
22-S-107	61.5L	0+15.0	-5.5	85.8	1.36 \pm 0.29	2.18 \pm 0.31	2.15 \pm 0.29	42.8 \pm 2.1	41.3 \pm 2.1	29.4 \pm 1.5
22-S-097	62.5L	0+03.0	-2.2	84.1	1.97 \pm 0.38	1.04 \pm 0.30	1.19 \pm 0.31	23.4 \pm 2.4	23.6 \pm 2.0	16.3 \pm 1.4
22-S-108	62.5L	0+19.0	-5.0	86.8	0.38 \pm 0.20	BDL	BDL	26.2 \pm 1.7	24.6 \pm 1.9	18.4 \pm 1.4
22-S-110	63.5L	0+03.0	-1.5	82.2	1.55 \pm 0.12	1.34 \pm 0.27	0.89 \pm 0.23	20.6 \pm 0.7	23.1 \pm 1.7	13.1 \pm 1.0
22-S-109	63.5L	0+03.0	-3.0	84.9	1.84 \pm 0.16	2.39 \pm 0.29	1.81 \pm 0.20	27.3 \pm 1.0	28.2 \pm 1.8	16.6 \pm 1.1
22-S-114	63.5L	0+13.0	-6.0	83.1	1.34 \pm 0.31	1.55 \pm 0.29	1.69 \pm 0.27	22.7 \pm 2.0	22.1 \pm 1.9	20.2 \pm 1.7
22-S-115	63.5L	0+13.0	-5.5	82.9	1.43 \pm 0.33	1.50 \pm 0.31	1.67 \pm 0.25	26.7 \pm 2.0	20.8 \pm 2.0	14.7 \pm 1.2
22-S-111	70.5L	0+15.0	-5.0	82.9	1.45 \pm 0.70	BDL	1.32 \pm 0.48	30.0 \pm 4.1	21.5 \pm 2.9	13.7 \pm 1.9
22-S-252	73.5L	0+19.5	-6.5	86.6	1.53 \pm 0.34	1.25 \pm 0.32	1.58 \pm 0.28	32.4 \pm 2.3	36.8 \pm 2.4	28.3 \pm 1.6
22-S-253	75.5L	0+22.5	-8.1	84.8	1.69 \pm 0.47	1.12 \pm 0.45	2.54 \pm 0.45	35.4 \pm 2.5	36.5 \pm 2.6	27.1 \pm 1.9
22-S-112	76.5L	0+21.0	-3.5	84.5	1.66 \pm 0.27	2.06 \pm 0.31	1.22 \pm 0.27	34.1 \pm 1.8	35.6 \pm 2.4	20.0 \pm 1.4
22-S-136	81.5L	0+23.0	-2.0	83.5	1.51 \pm 0.30	1.42 \pm 0.29	1.29 \pm 0.21	30.8 \pm 1.9	28.3 \pm 1.8	16.6 \pm 1.1
22-S-030	83.5L	0+23.0	-0.3	70.6	0.81 \pm 0.08	BDL	1.42 \pm 0.47	20.0 \pm 0.4	25.8 \pm 2.5	14.8 \pm 1.8
22-S-031	83.5L	0+23.0	-0.7	77.7	1.54 \pm 0.25	1.68 \pm 0.58	1.68 \pm 0.42	22.1 \pm 1.3	23.7 \pm 2.7	14.4 \pm 1.9

TABLE D.6 (Cont'd)

Sample No.	Coordinates			Dry Wt %	Th-232 (911 keV)			K-40 (1460 keV)		
	X	Y	Z		pc/g $\pm \sigma$	--Initial--	--Aged--	pc/g $\pm \sigma$	--Initial--	--Aged--
22-S-034	83.5L	0+23.0	-0.9	78.7	1.16 \pm 0.25	BDL	1.00 \pm 0.39	20.0 \pm 1.4	26.8 \pm 2.5	17.1 \pm 1.7
22-S-035	83.5L	0+23.0	-1.1	81.5	1.33 \pm 0.18	1.49 \pm 0.32	1.26 \pm 0.27	20.7 \pm 1.0	19.2 \pm 1.7	15.8 \pm 1.3
22-S-036	83.5L	0+23.0	-1.4	81.3	1.70 \pm 0.17	NA	2.27 \pm 0.15	21.6 \pm 1.0	NA	22.5 \pm 0.6
22-S-036	83.5L	0+23.0	-1.4	81.3	1.70 \pm 0.17	NA	1.84 \pm 0.13	21.6 \pm 1.0	NA	21.7 \pm 0.6
22-S-039	83.5L	0+23.0	-1.7	84.1	1.18 \pm 0.18	NA	1.93 \pm 0.11	22.1 \pm 1.1	NA	22.1 \pm 0.6
22-S-039	83.5L	0+23.0	-1.7	84.1	1.18 \pm 0.18	NA	1.89 \pm 0.13	22.1 \pm 1.1	NA	21.4 \pm 0.5
22-S-037	83.5L	0+23.0	-2.0	88.1	1.63 \pm 0.16	1.92 \pm 0.27	1.47 \pm 0.24	41.2 \pm 1.3	39.1 \pm 2.0	25.0 \pm 1.4
22-S-038	83.5L	0+23.0	-2.0	87.9	1.77 \pm 0.22	1.69 \pm 0.30	1.45 \pm 0.27	37.5 \pm 1.6	42.7 \pm 2.1	29.8 \pm 1.5
22-S-135	84.5L	0+18.0	-2.0	86.7	1.67 \pm 0.27	1.25 \pm 0.26	1.44 \pm 0.20	37.3 \pm 2.0	37.5 \pm 1.9	23.4 \pm 1.2
22-S-137	84.5L	0+22.0	-2.0	86.4	1.68 \pm 0.38	1.57 \pm 0.41	1.40 \pm 0.31	35.5 \pm 2.4	36.0 \pm 2.4	23.7 \pm 1.4
22-S-133	85.5L	0+07.0	-3.0	86.1	2.15 \pm 0.46	2.43 \pm 0.42	2.11 \pm 0.32	53.3 \pm 3.1	55.6 \pm 3.0	33.0 \pm 1.8
22-S-134	85.5L	0+09.0	-3.5	85.9	2.21 \pm 0.32	2.48 \pm 0.36	1.40 \pm 0.24	40.9 \pm 2.4	41.8 \pm 2.3	28.0 \pm 1.4
22-S-032	93.5L	0+13.0	0.0	69.2	0.92 \pm 0.15	0.97 \pm 0.28	1.37 \pm 0.31	15.9 \pm 0.9	17.1 \pm 1.7	15.1 \pm 1.5
22-S-033	93.5L	0+13.0	-0.1	81.1	1.39 \pm 0.14	NA	2.01 \pm 0.13	19.6 \pm 0.8	NA	21.6 \pm 0.7
22-S-033	93.5L	0+13.0	-0.1	81.1	1.39 \pm 0.14	NA	1.84 \pm 0.14	19.6 \pm 0.8	NA	19.3 \pm 0.5
22-S-140	101.5L	0+05.0	-2.5	82.6	1.04 \pm 0.22	1.33 \pm 0.21	0.74 \pm 0.15	16.1 \pm 1.3	15.6 \pm 1.5	10.0 \pm 0.9
112 Stewart Avenue										
22-S-131	23.0L	0-6.0	-0.5	77.3	1.79 \pm 0.35	1.93 \pm 0.35	1.53 \pm 0.24	16.0 \pm 2.1	14.7 \pm 2.0	12.1 \pm 1.2
22-S-129	41.0L	0-19.0	-0.5	79.1	BDL	2.49 \pm 0.76	3.00 \pm 0.56	20.1 \pm 3.3	20.0 \pm 3.4	14.7 \pm 2.0
22-S-130	41.0L	0-19.0	-1.0	81.3	2.18 \pm 0.34	1.96 \pm 0.32	1.99 \pm 0.25	19.8 \pm 1.9	18.5 \pm 1.9	11.2 \pm 1.1
22-S-127	43.2L	0-05.0	-0.5	79.4	1.77 \pm 0.34	1.13 \pm 0.35	1.41 \pm 0.29	19.1 \pm 2.1	17.5 \pm 2.3	11.8 \pm 1.2
22-S-128	47.0L	0-06.0	-0.8	82.4	1.73 \pm 0.37	1.43 \pm 0.31	0.93 \pm 0.25	25.1 \pm 2.1	27.7 \pm 2.0	15.4 \pm 1.2
60 Union Street; Holes 38 and 39 in Region 27, Zon. 8.										
22-S-044	157.0L	0-06.5	-0.3	73.0	1.17 \pm 0.25	2.22 \pm 0.33	1.22 \pm 0.27	13.9 \pm 1.4	12.7 \pm 1.8	8.9 \pm 1.1
22-S-045	157.0L	0-06.5	-0.5	73.8	1.70 \pm 0.33	1.48 \pm 0.39	1.34 \pm 0.35	13.9 \pm 1.7	13.6 \pm 1.9	8.4 \pm 1.2
22-S-046	157.0L	0-06.5	-0.8	79.0	1.46 \pm 0.28	1.82 \pm 0.31	0.78 \pm 0.25	14.0 \pm 1.6	18.9 \pm 1.8	10.7 \pm 1.2
22-S-047	157.0L	0-06.5	-1.0	78.6	1.44 \pm 0.30	1.37 \pm 0.24	1.13 \pm 0.20	18.5 \pm 1.4	20.1 \pm 1.6	12.5 \pm 0.9
22-S-040	157.0L	0-14.5	-0.3	78.7	1.24 \pm 0.25	1.37 \pm 0.27	0.83 \pm 0.24	14.7 \pm 1.6	16.0 \pm 1.5	11.6 \pm 1.2
22-S-041	157.0L	0-14.5	-0.5	81.3	1.39 \pm 0.06	1.73 \pm 0.25	1.34 \pm 0.22	16.4 \pm 0.3	17.0 \pm 1.4	10.7 \pm 1.1
22-S-042	157.0L	0-14.5	-0.8	79.7	1.39 \pm 0.16	1.38 \pm 0.24	0.97 \pm 0.16	15.8 \pm 1.0	15.3 \pm 1.5	10.6 \pm 0.9
22-S-043	157.0L	0-14.5	-1.0	81.0	1.45 \pm 0.10	1.02 \pm 0.23	1.05 \pm 0.17	15.4 \pm 0.6	16.5 \pm 1.3	8.9 \pm 0.8
99 Stratford Avenue										
22-S-126	4.5R	0+51.7	-0.3	81.2	0.86 \pm 0.36	1.37 \pm 0.28	1.00 \pm 0.26	17.5 \pm 2.2	17.8 \pm 1.9	10.7 \pm 1.3

TABLE D.6 (Cont'd)

Sample No.	Coordinates			Dry Wt %	Th-232 (911 keV)				K-40 (1460 keV)			
	X	Y	Z		--Initial--	--Aged--	--Dried--		--Initial--	--Aged--	--Dried--	
						pCi/g \pm σ				pCi/g \pm σ		
115 Stratford Avenue												
22-S-117	168.8L	0+02.0	-0.3	63.6	1.82 \pm 0.52	BDL	BDL		18.5 \pm 3.6	16.4 \pm 3.2	10.6 \pm 1.8	
22-S-118	168.8L	0+02.0	-0.6	68.3	0.84 \pm 0.45	BDL	BDL		18.6 \pm 2.7	10.8 \pm 2.7	13.4 \pm 1.6	
22-S-119	168.8L	0+02.0	-0.9	90.9	BDL	0.89 \pm 0.50	BDL		22.6 \pm 2.7	22.0 \pm 2.7	12.1 \pm 1.5	
22-S-120	168.8L	0+02.0	-1.2	93.1	1.23 \pm 0.30	1.08 \pm 0.30	0.69 \pm 0.32		18.1 \pm 2.2	27.7 \pm 2.1	16.2 \pm 1.2	
22-S-121	168.8L	0+02.0	-1.5	93.5	1.07 \pm 0.33	1.44 \pm 0.30	1.27 \pm 0.22		24.6 \pm 2.1	24.0 \pm 2.0	14.3 \pm 1.2	
22-S-122	203.0L	0+04.0	-0.3	88.4	0.99 \pm 0.38	1.35 \pm 0.30	0.63 \pm 0.25		22.4 \pm 2.1	23.7 \pm 2.1	15.1 \pm 1.3	
22-S-123	203.0L	0+04.0	-0.5	90.3	0.76 \pm 0.30	1.67 \pm 0.30	0.97 \pm 0.24		22.3 \pm 1.9	24.3 \pm 1.8	11.7 \pm 1.1	
22-S-124	203.0L	0+04.0	-0.8	81.9	1.46 \pm 0.26	1.28 \pm 0.27	1.14 \pm 0.1		21.8 \pm 1.8	23.2 \pm 1.7	12.3 \pm 0.9	
22-S-125	203.0L	0+04.0	-1.0	83.0	1.10 \pm 0.24	1.71 \pm 0.22	0.89 \pm 0.1		24.7 \pm 1.8	24.8 \pm 1.7	14.9 \pm 1.0	
Ave				83.1	1.48	1.60	1.44		27.0	27.7	18.8	
Std Dev				5.5	0.39	0.45	0.47		11.0	11.4	8.0	
Max				93.5	2.45	3.04	3.00		56.5	55.6	42.7	
Min				63.6	0.38	0.70	0.60		13.9	10.8	8.4	
No of Samples				73	71	62	70		73	67	73	

*Samples dried and analyzed by the ACL.

 σ Uncertainty in the counting statistics.

NA = Data Not Available.

BDL = Below Detectable Level.

TABLE D.7 Ra-226 Analyses of Soil Samples Collected Along Stratford Avenue Sewer Line

Sample No.	Description	Ra-226 (186 keV)			Pb-214 (352 keV)			Bi-214 (609 keV)		
		--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
			pCi/g $\pm \sigma$			pCi/g $\pm \sigma$			pCi/g $\pm \sigma$	
laterals to site										
22-S-386	105 drain	1330. ± 11.1	1420. ± 11.8	NA	1440. ± 2.87	1530. ± 2.91	NA	1780. ± 3.84	1680. ± 3.41	NA
22-S-399	above 105 drain	2.98 ± 0.64	3.33 ± 0.75	4.16 ± 0.99	1.73 ± 0.11	2.47 ± 0.11	3.47 ± 0.16	2.37 ± 0.15	2.74 ± 0.13	2.99 ± 0.18
22-S-400	above 105 drain	2.38 ± 0.53	1.79 ± 0.56	2.64 ± 0.89	0.65 ± 0.08	1.17 ± 0.09	1.76 ± 0.12	0.78 ± 0.10	1.38 ± 0.11	1.61 ± 0.13
22-S-412	105 drain	89.4 ± 2.25	NA	144. ± 4.22	48.90 ± 0.45	NA	134. ± 0.89	53.20 ± 0.55	NA	130. ± 0.96
22-S-416	105 drain	194. ± 3.23	NA	372. ± 6.59	122. ± 0.64	FA	327. ± 1.32	137.00 ± 0.79	NA	324. ± 1.41
22-S-410	old gas line	1.84 ± 0.49	BDL	1.34 ± 0.63	0.52 ± 0.08	0.74 ± 0.08	0.77 ± 0.10	0.85 ± 0.09	0.85 ± 0.09	0.64 ± 0.11
22-S-387	107 drain	26.1 ± 1.28	27.6 ± 1.45	46.9 ± 2.78	14.0 ± 0.28	24.4 ± 0.34	41.4 ± 0.57	17.4 ± 0.38	27.8 ± 0.43	39.4 ± 0.60
new manhole										
22-S-409	1-1.5 ft deep	1.26 ± 0.49	BDL	1.60 ± 0.69	0.71 ± 0.07	0.76 ± 0.09	0.70 ± 0.09	0.92 ± 0.09	0.73 ± 0.09	0.76 ± 0.12
22-S-411	7 ft deep	BDL	1.53 ± 0.50	BDL	1.93 ± 0.10	1.14 ± 0.09	1.16 ± 0.12	2.99 ± 0.15	1.04 ± 0.10	1.31 ± 0.14
22-S-415	west wall	3.22 ± 0.71	1.83 ± 0.68	3.65 ± 0.88	1.75 ± 0.11	2.31 ± 0.12	2.49 ± 0.15	2.36 ± 0.14	2.65 ± 0.14	2.79 ± 0.17
22-S-417	west wall	5.17 ± 0.70	4.54 ± 0.69	6.27 ± 1.04	1.79 ± 0.09	3.94 ± 0.12	5.00 ± 0.20	2.10 ± 0.11	4.47 ± 0.16	4.54 ± 0.22
22-S-418	SE corner	4.66 ± 0.60	2.71 ± 0.66	5.40 ± 0.99	2.12 ± 0.10	2.84 ± 0.11	3.59 ± 0.17	2.40 ± 0.12	3.27 ± 0.14	4.80 ± 0.20
22-S-419	SW corner	5.60 ± 0.89	13.5 ± 0.99	27.1 ± 1.93	6.92 ± 0.18	13.5 ± 0.21	24.4 ± 0.39	10.7 ± 0.22	14.7 ± 0.27	23.5 ± 0.42
22-S-420	N corner	8.50 ± 0.89	18.3 ± 1.16	27.6 ± 1.85	9.43 ± 0.18	19.0 ± 0.25	28.1 ± 0.41	10.6 ± 0.22	21.1 ± 0.31	27.8 ± 0.42
22-S-421	N corner	5.08 ± 0.63	5.09 ± 0.69	6.34 ± 0.97	3.04 ± 0.12	5.16 ± 0.14	5.52 ± 0.19	3.25 ± 0.14	5.57 ± 0.18	6.55 ± 0.21
22-S-422	NW corner	1.10 ± 1.97	NA	95.1 ± 3.74	28.6 ± 0.38	NA	89.3 ± 0.79	35.4 ± 0.48	NA	85.8 ± 0.87
22-S-423	NW corner	2.90 ± 0.96	11.8 ± 1.06	14.8 ± 1.59	7.84 ± 0.19	9.34 ± 0.20	11.2 ± 0.27	10.4 ± 0.24	9.89 ± 0.24	11.6 ± 0.29
22-S-424	NW corner 4"	61.2 ± 1.90	NA	106. ± 3.38	33.1 ± 0.36	NA	81.1 ± 0.68	41.2 ± 0.45	NA	80.0 ± 0.71
22-S-425	NW corner 8"	74.8 ± 1.96	75.7 ± 2.26	100. ± 3.33	31.9 ± 0.35	61.9 ± 0.50	84.7 ± 0.67	40.2 ± 0.46	67.9 ± 0.60	83.0 ± 0.74
22-S-426	NW corner 16"	47.8 ± 1.54	50.6 ± 1.72	68.00 ± 2.60	25.4 ± 0.31	38.3 ± 0.40	49.8 ± 0.57	34.1 ± 0.41	43.2 ± 0.47	56.7 ± 0.62
22-S-427	NW corner 24"	47.3 ± 1.56	44.6 ± 1.65	63.90 ± 2.69	21.9 ± 0.29	37.8 ± 0.38	54.9 ± 0.56	26.7 ± 0.37	41.8 ± 0.46	54.6 ± 0.59
22-S-430	SW corner	68.9 ± 1.61	62.7 ± 2.13	92.40 ± 2.91	21.8 ± 0.30	53.9 ± 0.45	60.8 ± 0.61	29.0 ± 0.39	60.8 ± 0.55	69.2 ± 0.66
22-S-509	after decon	1.28 ± 0.51	1.50 ± 0.58	2.82 ± 0.92	0.82 ± 0.08	0.69 ± 0.10	1.24 ± 0.12	0.90 ± 0.09	0.56 ± 0.13	1.22 ± 0.12
old manhole										
22-S-561	joint	142. ± 3.15	144. ± 3.67	223. ± 5.66	73.5 ± 0.62	105. ± 0.72	148.0 ± 1.03	87.3 ± 0.78	118. ± 0.92	143. ± 1.11
22-S-563	after decon	17.1 ± 0.93	18.1 ± 1.34	28.5 ± 1.76	7.79 ± 0.18	14.1 ± 0.25	15.1 ± 0.28	11.0 ± 0.24	16.0 ± 0.31	15.1 ± 0.31
22-S-565	after decon	11.4 ± 0.81	12.3 ± 1.05	19.5 ± 1.54	2.97 ± 0.12	11.2 ± 0.23	11.8 ± 0.27	3.36 ± 0.15	12.4 ± 0.28	11.1 ± 0.28
22-S-566	after decon	7.90 ± 0.81	8.04 ± 0.91	NA	2.53 ± 0.11	6.48 ± 0.18	NA	2.74 ± 0.13	6.93 ± 0.22	NA
22-S-569	after decon	6.90 ± 0.80	8.79 ± 0.92	NA	2.83 ± 0.12	5.40 ± 0.18	NA	3.32 ± 0.15	6.14 ± 0.23	NA
22-S-484	after decon	1.81 ± 0.64	2.85 ± 0.69	4.65 ± 1.05	1.69 ± 0.11	1.40 ± 0.10	2.42 ± 0.15	1.74 ± 0.13	1.59 ± 0.12	2.26 ± 0.15
22-S-506	after decon	8.95 ± 0.70	NA	NA	3.25 ± 0.12	NA	NA	3.70 ± 0.14	NA	NA
22-S-515	after decon	3.87 ± 0.62	4.00 ± 0.80	6.89 ± 0.94	1.76 ± 0.08	2.99 ± 0.13	4.14 ± 0.17	1.76 ± 0.11	3.17 ± 0.16	4.10 ± 0.17
22-S-564	hot joint	19.5 ± 1.05	18.8 ± 1.22	31.5 ± 1.99	5.97 ± 0.16	13.4 ± 0.25	20.0 ± 0.34	7.35 ± 0.22	15.5 ± 0.32	18.3 ± 0.36
22-S-567	after decon	8.25 ± 0.82	10.0 ± 1.13	13.8 ± 1.37	3.45 ± 0.13	7.57 ± 0.20	9.22 ± 0.24	3.65 ± 0.15	8.28 ± 0.24	8.88 ± 0.26

TABLE D.7 (Cont'd)

Sample No.	Description	Ra-226 (186 keV)			Pb-214 (352 keV)			Bi-214 (609 keV)		
		--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
		pCi/g $\pm \sigma$	pCi/g $\pm \sigma$	pCi/g $\pm \sigma$	pCi/g $\pm \sigma$	pCi/g $\pm \sigma$	pCi/g $\pm \sigma$	pCi/g $\pm \sigma$	pCi/g $\pm \sigma$	pCi/g $\pm \sigma$
22-S-514	new and old sewer pipes	5.78 \pm 0.73	5.82 \pm 0.83	8.38 \pm 1.24	2.28 \pm 0.11	3.91 \pm 0.15	6.26 \pm 0.19	2.22 \pm 0.13	4.22 \pm 0.19	6.25 \pm 0.21
22-S-516	below new pipe	24.0 \pm 1.26	25.9 \pm 1.56	37.8 \pm 2.32	9.16 \pm 0.22	20.2 \pm 0.32	28.5 \pm 0.45	11.3 \pm 0.28	21.4 \pm 0.40	27.2 \pm 0.47
22-S-517	resample	5.61 \pm 0.86	6.89 \pm 1.03	10.1 \pm 1.39	1.96 \pm 0.11	4.32 \pm 0.18	6.21 \pm 0.22	2.04 \pm 0.14	5.14 \pm 0.23	6.04 \pm 0.24
22-S-518	resample	3.94 \pm 0.69	4.02 \pm 0.70	2.78 \pm 0.94	1.77 \pm 0.10	2.18 \pm 0.13	2.03 \pm 0.14	2.17 \pm 0.13	2.46 \pm 0.16	1.78 \pm 0.16
22-S-508	below new pipe	8.75 \pm 0.70	8.28 \pm 0.85	10.8 \pm 1.23	3.31 \pm 0.12	6.33 \pm 0.19	8.67 \pm 0.24	3.84 \pm 0.15	6.49 \pm 0.21	8.57 \pm 0.26
22-S-507	below new pipe	16.9 \pm 0.97	16.7 \pm 1.01	23.7 \pm 1.88	10.6 \pm 0.18	13.0 \pm 0.22	25.3 \pm 0.37	11.9 \pm 0.23	14.2 \pm 0.27	24.6 \pm 0.39
22-S-505	below new pipe	8.00 \pm 0.81	8.26 \pm 0.94	8.94 \pm 1.33	2.55 \pm 0.11	4.71 \pm 0.19	7.76 \pm 0.24	2.87 \pm 0.14	5.30 \pm 0.23	7.59 \pm 0.26
22-S-510	below new pipe	3.46 \pm 0.57	5.07 \pm 0.77	6.46 \pm 1.32	1.53 \pm 0.09	2.12 \pm 0.12	3.92 \pm 0.16	1.78 \pm 0.11	2.34 \pm 0.15	3.75 \pm 0.18
22-S-562	below old pipe	614. \pm 4.34	614. \pm 6.90	NA	118. \pm 0.69	422. \pm 1.32	NA	131. \pm 0.87	472. \pm 1.64	NA
22-S-511	below new pipe	19.3 \pm 0.98	17.3 \pm 1.16	28.5 \pm 1.79	7.47 \pm 0.17	16.1 \pm 0.25	22.0 \pm 0.36	8.48 \pm 0.21	18.7 \pm 0.32	21.2 \pm 0.38
22-S-512	below new pipe	2.44 \pm 0.50	2.38 \pm 0.67	4.64 \pm 0.83	1.01 \pm 0.08	1.23 \pm 0.11	2.00 \pm 0.13	1.18 \pm 0.09	1.62 \pm 0.13	1.63 \pm 0.13
22-S-560	below old pipe	311. \pm 3.80	330. \pm 4.66	640. \pm 9.32	130. \pm 0.73	276. \pm 1.06	408. \pm 1.71	143. \pm 0.92	307. \pm 1.33	398. \pm 1.86
22-S-513	below new pipe	2.82 \pm 0.65	3.61 \pm 0.80	4.10 \pm 1.24	1.16 \pm 0.09	1.39 \pm 0.13	2.75 \pm 0.15	1.17 \pm 0.11	1.34 \pm 0.16	2.85 \pm 0.17
22-S-559	below old pipe	215. \pm 2.92	225. \pm 4.03	415. \pm 6.97	66.2 \pm 0.53	174. \pm 0.86	271.0 \pm 1.30	73.3 \pm 0.65	196. \pm 1.08	261. \pm 1.40
22-S-482	below new pipe	7.66 \pm 0.79	7.83 \pm 0.84	12.6 \pm 1.45	3.81 \pm 0.14	6.19 \pm 0.18	11.60 \pm 0.30	4.06 \pm 0.17	6.54 \pm 0.22	10.8 \pm 0.31
*22-S-504	below new pipe	21.8 \pm 1.23	18.9 \pm 1.38	NA	19.8 \pm 0.28	19.9 \pm 0.32	16.33 \pm 0.08	22.2 \pm 0.35	22.1 \pm 0.39	16.7 \pm 0.08
22-S-481	below new pipe	BDL	BDL	3.33 \pm 1.02	0.65 \pm 0.09	1.10 \pm 0.09	1.69 \pm 0.14	0.83 \pm 0.11	1.39 \pm 0.12	1.85 \pm 0.15
22-S-503	below new pipe	5.17 \pm 0.61	3.95 \pm 0.68	6.84 \pm 1.06	2.36 \pm 0.10	3.81 \pm 0.16	5.04 \pm 0.19	2.69 \pm 0.13	4.22 \pm 0.20	4.44 \pm 0.20
22-S-460	below old pipe	15.6 \pm 0.90	15.2 \pm 0.99	26.7 \pm 1.76	9.01 \pm 0.18	16.7 \pm 0.23	23.4 \pm 0.38	10.9 \pm 0.22	18.3 \pm 0.28	21.80 \pm 0.39
22-S-483	below new pipe	3.67 \pm 0.69	1.83 \pm 0.57	4.98 \pm 1.05	1.36 \pm 0.09	1.77 \pm 0.10	3.07 \pm 0.17	1.32 \pm 0.11	1.79 \pm 0.13	2.82 \pm 0.17
*22-S-457	over broken pipe	1.41 \pm 0.63	1.62 \pm 0.57	NA	1.45 \pm 0.09	1.74 \pm 0.09	2.89 \pm 0.03	1.73 \pm 0.12	1.99 \pm 0.12	3.08 \pm 0.05
22-S-462	below new pipe	1.44 \pm 0.56	BDL	2.22 \pm 0.74	0.75 \pm 0.07	0.70 \pm 0.08	0.97 \pm 0.11	0.90 \pm 0.08	0.77 \pm 0.08	1.03 \pm 0.11
22-S-461	below new pipe	BDL	1.48 \pm 0.49	2.33 \pm 0.78	0.90 \pm 0.07	0.98 \pm 0.08	1.26 \pm 0.12	0.87 \pm 0.09	1.15 \pm 0.10	1.38 \pm 0.13
22-S-459	below new pipe	1.40 \pm 0.48	2.85 \pm 0.55	3.04 \pm 0.86	0.78 \pm 0.07	0.86 \pm 0.09	1.09 \pm 0.12	0.96 \pm 0.09	1.04 \pm 0.10	1.03 \pm 0.12
22-S-458	below new pipe	1.15 \pm 0.48	1.48 \pm 0.47	2.18 \pm 0.66	0.73 \pm 0.07	0.75 \pm 0.07	1.79 \pm 0.10	0.79 \pm 0.09	0.99 \pm 0.09	1.42 \pm 0.11
22-S-456	below new pipe	BDL	BDL	BDL	0.59 \pm 0.07	0.88 \pm 0.07	1.10 \pm 0.08	0.78 \pm 0.08	1.03 \pm 0.08	1.00 \pm 0.09
22-S-453	below new pipe	1.78 \pm 0.45	2.08 \pm 0.46	1.79 \pm 0.58	0.69 \pm 0.07	1.05 \pm 0.07	1.17 \pm 0.08	0.95 \pm 0.08	1.17 \pm 0.09	1.13 \pm 0.09
22-S-445	below new pipe	2.39 \pm 0.56	2.13 \pm 0.54	3.45 \pm 0.92	1.57 \pm 0.09	1.74 \pm 0.09	2.53 \pm 0.15	1.77 \pm 0.10	2.04 \pm 0.11	2.02 \pm 0.16
22-S-447	by anchor pipe	2.09 \pm 0.62	3.32 \pm 0.52	5.27 \pm 1.00	1.50 \pm 0.08	2.04 \pm 0.09	3.06 \pm 0.15	1.67 \pm 0.10	2.19 \pm 0.12	2.94 \pm 0.16
22-S-449	hot joint	74.6 \pm 1.74	83.3 \pm 2.31	112. \pm 3.02	50.3 \pm 0.40	84.4 \pm 0.51	91.9 \pm 0.59	61.8 \pm 0.50	93.8 \pm 0.63	88.8 \pm 0.63
22-S-452	below new pipe	1.73 \pm 0.55	1.72 \pm 0.47	1.57 \pm 0.55	0.81 \pm 0.07	1.51 \pm 0.08	1.33 \pm 0.09	1.16 \pm 0.08	1.37 \pm 0.09	1.48 \pm 0.09
22-S-609	below old pipe	3.19 \pm 0.61	4.08 \pm 0.87	NA	1.49 \pm 0.09	3.73 \pm 0.14	NA	1.67 \pm 0.11	3.65 \pm 0.15	NA

TABLE D.7 (Cont'd)

Sample No.	Description	Ra-226 (186 keV)				Pb-214 (352 keV)				Bi-214 (609 keV)			
		--Initial--	--Aged--	--Dried--		--Initial--	--Aged--	--Dried--		--Initial--	--Aged--	--Dried--	
			pCi/g $\pm \sigma$				pCi/g $\pm \sigma$				pCi/g $\pm \sigma$		
22-S-413	above sewer	BDL	BDL	BDL	BDL	0.44 \pm 0.07	0.62 \pm 0.07	0.60 \pm 0.09	0.80 \pm 0.09	0.62 \pm 0.10	0.54 \pm 0.10		
22-S-414	above sewer	1.78 \pm 0.62	2.69 \pm 0.59	3.11 \pm 0.84	BDL	1.59 \pm 0.10	1.87 \pm 0.10	1.81 \pm 0.13	2.00 \pm 0.12	2.22 \pm 0.12	1.70 \pm 0.15		
22-S-446	after decon	BDL	BDL	BDL	BDL	0.84 \pm 0.07	0.69 \pm 0.07	1.03 \pm 0.10	1.13 \pm 0.09	0.69 \pm 0.08	0.76 \pm 0.11		
22-S-448	below new pipe	1.46 \pm 0.47	1.08 \pm 0.45	2.87 \pm 0.74	BDL	0.88 \pm 0.06	1.13 \pm 0.07	1.10 \pm 0.11	0.93 \pm 0.08	1.22 \pm 0.09	1.27 \pm 0.11		
22-S-454	above sewer	BDL	1.63 \pm 0.57	2.66 \pm 0.65	BDL	0.54 \pm 0.07	0.75 \pm 0.08	0.79 \pm 0.10	0.55 \pm 0.08	0.74 \pm 0.09	1.10 \pm 0.10		
22-S-408	below new pipe	3.36 \pm 0.55	4.31 \pm 0.76	6.17 \pm 1.20	BDL	3.03 \pm 0.13	2.95 \pm 0.12	3.68 \pm 0.19	3.24 \pm 0.15	3.48 \pm 0.15	3.72 \pm 0.21		
22-S-443	below new pipe	BDL	BDL	1.29 \pm 0.67	BDL	0.58 \pm 0.06	0.73 \pm 0.07	1.03 \pm 0.10	0.69 \pm 0.07	0.85 \pm 0.08	1.03 \pm 0.11		
22-S-444	after decon	1.96 \pm 0.53	1.19 \pm 0.54	2.16 \pm 0.81	BDL	1.91 \pm 0.09	2.44 \pm 0.10	2.72 \pm 0.15	2.30 \pm 0.11	2.53 \pm 0.12	3.00 \pm 0.17		
*22-S-437	below new pipe	2.39 \pm 0.51	2.10 \pm 0.52	NA	BDL	1.73 \pm 0.09	2.01 \pm 0.10	3.45 \pm 0.03	1.94 \pm 0.11	2.44 \pm 0.12	3.60 \pm 0.04		
22-S-433	below new pipe	BDL	1.28 \pm 0.51	BDL	BDL	1.24 \pm 0.09	0.99 \pm 0.08	1.22 \pm 0.14	1.46 \pm 0.10	1.03 \pm 0.09	1.40 \pm 0.15		
22-S-432	Union manhole	BDL	1.58 \pm 0.45	BDL	BDL	0.52 \pm 0.07	0.73 \pm 0.07	0.94 \pm 0.13	0.72 \pm 0.08	0.87 \pm 0.08	0.89 \pm 0.12		
Ave		56.06	54.20	47.99		31.62	43.51	31.51	38.16	48.15	30.98		
Std dev		181.75	195.77	108.73		164.80	188.49	72.11	203.36	207.34	70.52		
Max		1330.	1420.	640.		1440.	1530.	408.	1780.	1680.	398.		
Min		1.15	1.08	1.29		0.44	0.62	0.60	0.55	0.56	0.54		
No. of Samples		66	63	61		76	71	70	76	71	70		

*Samples dried and analyzed by the ACL.

Uncertainty in the counting statistics.

NA = data Not Available; ACL does not report the 186 keV activity.

BDL = Below Detectable Level.

TABLE D.8 Th-232 and K-40 Analyses of Soil Samples Collected Along Stratford Avenue Sewer Line

Sample No.	Description	% Dry Weight	Tn-232 (911 keV)				K-40 (1460 keV)			
			--Initial--	--Aged--	--Dried--	pCi/g \pm σ	--Initial--	--Aged--	--Dried--	pCi/g \pm σ
laterals to site										
22-S-386	75L 0+95 105 drain	NA	BDL	BDL	NA	BDL	BDL	BDL	NA	
22-S-399	75L 0+95 above 105 drain	85.6	1.25 \pm 0.26	1.65 \pm 0.20	0.96 \pm 0.25	23.6 \pm 1.8	14.7 \pm 1.2	14.7 \pm 1.2	15.3 \pm 1.3	
22-S-400	75L 0+95 above 105 drain	88.8	0.93 \pm 0.28	1.32 \pm 0.21	1.40 \pm 0.21	26.5 \pm 1.7	17.1 \pm 1.2	17.1 \pm 1.2	15.7 \pm 1.2	
22-S-412	65L 1+65 105 drain	87.5	BDL	NA	1.39 \pm 0.71	22.2 \pm 2.2	NA	NA	20.0 \pm 2.9	
22-S-416	65L 1+75 105 drain	76.8	BDL	NA	BDL	7.6 \pm 2.4	NA	NA	13.7 \pm 3.6	
22-S-410	65L 1+75 old gas line	91.0	0.71 \pm 0.19	1.19 \pm 0.19	1.17 \pm 0.19	16.6 \pm 1.3	16.6 \pm 1.2	16.6 \pm 1.2	16.2 \pm 1.2	
22-S-387	82L 0+95 107 drain	82.2	0.83 \pm 0.46	1.40 \pm 0.43	1.26 \pm 0.51	22.9 \pm 2.4	13.3 \pm 1.8	13.3 \pm 1.8	16.9 \pm 2.0	
new manhole										
22-S-409	65L 1+75 1-1.5 ft deep	89.6	1.05 \pm 0.18	0.76 \pm 0.20	0.96 \pm 0.19	18.0 \pm 1.2	21.3 \pm 1.3	21.3 \pm 1.3	14.7 \pm 1.2	
22-S-411	65L 1+75 7 ft deep	82.0	1.38 \pm 0.21	1.42 \pm 0.18	1.28 \pm 0.26	14.9 \pm 1.2	18.9 \pm 1.1	18.9 \pm 1.1	13.8 \pm 1.2	
22-S-415	65L 1+75 west wall	92.2	1.18 \pm 0.24	1.10 \pm 0.24	0.86 \pm 0.23	23.0 \pm 1.5	21.0 \pm 1.5	21.0 \pm 1.5	18.7 \pm 1.2	
22-S-417	65L 1+75 west wall	85.1	1.21 \pm 0.18	1.13 \pm 0.21	1.35 \pm 0.25	15.6 \pm 1.0	15.9 \pm 1.1	15.9 \pm 1.1	17.0 \pm 1.4	
22-S-418	65L 1+75 SE corner	84.4	1.16 \pm 0.18	1.09 \pm 0.19	1.28 \pm 0.23	14.0 \pm 1.2	16.1 \pm 1.1	16.1 \pm 1.1	14.7 \pm 1.3	
22-S-419	65L 1+75 SW corner	99.3	0.99 \pm 0.23	0.96 \pm 0.26	1.24 \pm 0.44	14.8 \pm 1.2	13.6 \pm 1.3	13.6 \pm 1.3	15.6 \pm 1.5	
22-S-420	65L 1+75 NW corner	80.8	0.56 \pm 0.25	0.52 \pm 0.29	1.39 \pm 0.36	14.4 \pm 1.2	16.6 \pm 1.4	16.6 \pm 1.4	16.3 \pm 1.5	
22-S-421	65L 1+75 NE corner	87.6	1.33 \pm 0.20	1.37 \pm 0.22	0.54 \pm 0.22	16.9 \pm 1.3	15.1 \pm 1.2	15.1 \pm 1.2	14.1 \pm 1.1	
22-S-422	65L 1+75 NW corner	87.9	BDL	NA	1.62 \pm 0.71	20.8 \pm 2.2	NA	NA	22.3 \pm 2.6	
22-S-423	65L 1+75 NW corner	93.4	0.97 \pm 0.28	0.99 \pm 0.31	1.23 \pm 0.29	19.5 \pm 1.5	19.4 \pm 1.5	19.4 \pm 1.5	18.5 \pm 1.5	
22-S-424	65L 1+75 NW corner 4"	90.4	0.84 \pm 0.39	NA	BDL	21.6 \pm 1.9	NA	NA	23.0 \pm 2.1	
22-S-425	65L 1+75 NW corner 8"	91.8	0.99 \pm 0.43	BDL	BDL	23.3 \pm 1.8	15.4 \pm 2.3	15.4 \pm 2.3	19.1 \pm 2.1	
22-S-426	65L 1+75 NW corner 16"	91.0	0.99 \pm 0.36	0.96 \pm 0.44	1.84 \pm 0.46	16.3 \pm 1.7	15.4 \pm 1.9	15.4 \pm 1.9	16.9 \pm 1.9	
22-S-427	65L 1+75 NW corner 24"	92.6	0.94 \pm 0.36	BDL	1.58 \pm 0.51	24.3 \pm 1.7	25.0 \pm 1.8	25.0 \pm 1.8	19.3 \pm 1.9	
22-S-430	65L 1+75 SW corner	93.9	1.25 \pm 0.39	1.19 \pm 0.48	1.19 \pm 0.56	18.0 \pm 1.8	24.1 \pm 2.2	24.1 \pm 2.2	23.5 \pm 1.9	
22-S-509	65L 1+75 after decon	87.3	1.24 \pm 0.16	0.79 \pm 0.25	1.00 \pm 0.21	21.9 \pm 1.1	13.5 \pm 1.5	13.5 \pm 1.5	14.7 \pm 1.1	
old manhole										
22-S-561	85L 1+75 joint	89.8	BDL	BDL	BDL	35.7 \pm 2.9	37.2 \pm 3.5	37.2 \pm 3.5	34.4 \pm 3.0	
22-S-563	85L 1+75 after decon	96.6	1.48 \pm 0.33	1.41 \pm 0.35	1.88 \pm 0.31	37.4 \pm 1.7	36.2 \pm 2.0	36.2 \pm 2.0	30.7 \pm 1.7	
22-S-565	85L 1+75 after decon	88.8	1.33 \pm 0.24	0.85 \pm 0.30	1.53 \pm 0.29	30.4 \pm 1.5	28.3 \pm 1.9	28.3 \pm 1.9	29.1 \pm 1.6	
22-S-568	85L 1+75 after decon	NA	1.89 \pm 0.22	0.96 \pm 0.28	NA	30.5 \pm 1.4	26.5 \pm 1.8	26.5 \pm 1.8	NA	
22-S-569	85L 1+75 after decon	NA	0.91 \pm 0.21	0.86 \pm 0.33	NA	33.5 \pm 1.6	31.7 \pm 1.9	31.7 \pm 1.9	NA	
22-S-484	95L 1+75 after decon	91.2	1.38 \pm 0.22	1.63 \pm 0.22	1.31 \pm 0.25	33.1 \pm 1.7	34.9 \pm 1.6	34.9 \pm 1.6	29.1 \pm 1.6	
22-S-506	95L 1+75 after decon	NA	1.12 \pm 0.20	NA	NA	28.4 \pm 1.3	NA	NA	NA	
22-S-515	95L 1+75 after decon	87.2	1.79 \pm 0.20	0.87 \pm 0.26	1.65 \pm 0.26	31.1 \pm 1.4	27.6 \pm 1.6	27.6 \pm 1.6	31.7 \pm 1.4	
22-S-564	95L 1+75 hot joint	94.2	1.33 \pm 0.28	1.43 \pm 0.36	1.46 \pm 0.38	33.3 \pm 1.8	35.8 \pm 2.2	35.8 \pm 2.2	29.8 \pm 1.7	
22-S-567	95L 1+75 after decon	89.4	0.68 \pm 0.24	1.68 \pm 0.32	1.28 \pm 0.27	33.4 \pm 1.5	29.1 \pm 1.9	29.1 \pm 1.9	30.1 \pm 1.6	

TABLE D.8 (Cont'd)

Sample No.	Description	% Dry Weight	Th-232 (911 keV) pCi/g \pm σ			K-40 (1460 keV) pCi/g \pm σ		
			--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
new and old sewer pipes								
22-S-514	55L 1+75 below new pipe	90.1	1.13 \pm 0.22	1.05 \pm 0.27	1.11 \pm 0.26	18.8 \pm 1.2	16.8 \pm 1.6	16.6 \pm 1.3
22-S-516	55L 1+75 resample	92.4	1.66 \pm 0.40	0.95 \pm 0.41	1.29 \pm 0.41	18.9 \pm 1.6	13.2 \pm 2.2	11.9 \pm 1.8
22-S-517	55L 1+75 resample	92.2	1.58 \pm 0.25	0.84 \pm 0.38	1.72 \pm 0.29	20.7 \pm 1.5	18.6 \pm 2.0	19.2 \pm 1.5
22-S-518	55L 1+75 resample	90.9	0.95 \pm 0.18	1.05 \pm 0.28	1.54 \pm 0.27	28.1 \pm 1.5	29.7 \pm 1.8	23.7 \pm 1.5
22-S-508	75L 1+75 below new pipe	88.6	0.72 \pm 0.21	1.00 \pm 0.26	0.77 \pm 0.25	25.4 \pm 1.4	25.1 \pm 1.8	26.1 \pm 1.5
22-S-507	85L 1+75 below new pipe	87.0	0.75 \pm 0.23	1.34 \pm 0.32	1.01 \pm 0.31	29.1 \pm 1.5	28.7 \pm 1.7	28.5 \pm 1.6
22-S-505	105L 1+75 below new pipe	87.7	1.69 \pm 0.25	1.13 \pm 0.35	1.73 \pm 0.31	34.5 \pm 1.6	28.7 \pm 2.1	30.0 \pm 1.7
22-S-510	115L 1+75 below new pipe	83.0	1.63 \pm 0.20	1.03 \pm 0.24	1.48 \pm 0.23	24.3 \pm 1.1	20.6 \pm 1.4	18.2 \pm 1.2
22-S-562	115L 1+85 below old pipe	NA	BDL	BDL	NA	27.6 \pm 2.8	25.4 \pm 5.3	NA
22-S-511	125L 1+75 below new pipe	84.8	1.27 \pm 0.22	0.66 \pm 0.35	1.28 \pm 0.33	13.7 \pm 1.3	12.5 \pm 1.7	14.9 \pm 1.5
22-S-512	135L 1+75 below new pipe	84.9	1.18 \pm 0.17	1.26 \pm 0.23	1.40 \pm 0.20	18.5 \pm 1.1	17.6 \pm 1.4	18.7 \pm 1.1
22-S-560	135L 1+85 below old pipe	88.4	1.26 \pm 0.59	BDL	BDL	27.1 \pm 3.2	17.8 \pm 4.2	22.9 \pm 4.8
22-S-513	145L 1+75 below new pipe	89.0	1.43 \pm 0.22	1.15 \pm 0.28	1.32 \pm 0.23	22.8 \pm 1.5	25.0 \pm 1.8	24.3 \pm 1.4
22-S-559	145L 1+85 below old pipe	86.6	BDL	BDL	BDL	21.0 \pm 2.5	16.5 \pm 3.9	17.6 \pm 3.8
22-S-482	155L 1+75 below new pipe	98.1	0.91 \pm 0.25	1.21 \pm 0.27	1.13 \pm 0.30	15.7 \pm 1.4	17.8 \pm 1.5	16.6 \pm 1.6
22-S-504	155L 1+75 below new pipe	91.3	1.17 \pm 0.31	0.97 \pm 0.40	1.12 \pm 0.06	15.8 \pm 1.6	16.7 \pm 2.1	16.6 \pm 1.6
22-S-481	165L 1+75 below new pipe	98.3	1.25 \pm 0.21	1.28 \pm 0.21	1.38 \pm 0.26	19.1 \pm 1.4	20.7 \pm 1.4	19.2 \pm 1.5
22-S-503	165L 1+75 below new pipe	89.8	1.46 \pm 0.20	1.04 \pm 0.26	1.33 \pm 0.24	15.4 \pm 1.2	12.8 \pm 1.7	14.8 \pm 1.2
22-S-460	175L 1+85 below old pipe	79.4	1.12 \pm 0.24	1.10 \pm 0.26	1.43 \pm 0.36	20.2 \pm 1.2	18.6 \pm 1.4	21.5 \pm 1.7
22-S-483	175L 1+75 below new pipe	97.0	1.17 \pm 0.19	1.31 \pm 0.21	1.81 \pm 0.25	18.9 \pm 1.2	26.4 \pm 1.2	15.0 \pm 1.3
22-S-457	185L 1+85 over broken pipe	75.1	1.21 \pm 0.17	0.95 \pm 0.20	0.92 \pm 0.05	15.1 \pm 1.1	14.3 \pm 1.1	16.2 \pm 0.4
22-S-462	185L 1+85 below new pipe	81.7	1.11 \pm 0.16	0.87 \pm 0.19	1.35 \pm 0.21	14.5 \pm 1.0	14.5 \pm 1.0	14.6 \pm 1.2
22-S-461	195L 1+85 below new pipe	80.9	1.01 \pm 0.16	1.13 \pm 0.17	1.40 \pm 0.22	13.5 \pm 1.0	14.1 \pm 1.0	14.5 \pm 1.2
22-S-459	205L 1+85 below new pipe	81.4	1.25 \pm 0.20	1.22 \pm 0.18	1.24 \pm 0.22	12.9 \pm 1.1	13.5 \pm 1.1	14.0 \pm 1.2
22-S-458	215L 1+85 below new pipe	78.6	0.83 \pm 0.15	0.85 \pm 0.17	0.89 \pm 0.16	13.6 \pm 1.0	11.2 \pm 1.0	12.6 \pm 0.9
22-S-456	225L 1+85 below new pipe	75.7	1.02 \pm 0.16	0.65 \pm 0.18	0.97 \pm 0.15	11.4 \pm 0.9	15.5 \pm 0.9	10.3 \pm 0.8
22-S-453	235L 1+85 below new pipe	79.1	1.24 \pm 0.17	1.14 \pm 0.17	0.85 \pm 0.14	9.4 \pm 1.0	13.3 \pm 0.9	10.3 \pm 0.8
22-S-445	245L 1+85 below new pipe	75.3	0.80 \pm 0.17	0.75 \pm 0.16	1.23 \pm 0.22	13.3 \pm 1.0	11.2 \pm 1.0	14.3 \pm 1.2
22-S-447	245L 1+85 by anchor pipe	79.5	1.25 \pm 0.16	0.69 \pm 0.17	1.04 \pm 0.23	14.1 \pm 1.0	14.0 \pm 1.0	16.2 \pm 1.2
22-S-449	245L 1+85 hot joint	72.2	BDL	BDL	0.99 \pm 0.49	12.7 \pm 1.8	11.1 \pm 1.9	11.6 \pm 1.8
22-S-452	245L 1+85 below new pipe	77.9	1.13 \pm 0.15	0.88 \pm 0.17	0.77 \pm 0.14	15.2 \pm 0.9	11.5 \pm 0.9	10.0 \pm 0.8
22-S-609	245L 1+85 below old pipe	NA	0.82 \pm 0.20	1.06 \pm 0.21	NA	13.7 \pm 1.1	11.1 \pm 1.0	NA

TABLE D.8 (Cont'd)

Sample No.	Description	% Dry Weight	Th-232 (911 keV) pCi/g \pm σ			K-40 (1460 keV) pCi/g \pm σ		
			--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
22-S-413	255L 1+85 above sewer	93.1	0.89 \pm 0.16	0.97 \pm 0.20	1.39 \pm 0.19	18.0 \pm 1.2	17.6 \pm 1.2	16.0 \pm 1.2
22-S-414	255L 1+85 above sewer	92.6	1.12 \pm 0.19	0.71 \pm 0.19	0.99 \pm 0.21	19.8 \pm 1.2	17.0 \pm 1.2	19.5 \pm 1.2
22-S-446	255L 1+85 after decon	83.6	0.81 \pm 0.16	0.97 \pm 0.17	1.22 \pm 0.22	14.7 \pm 1.1	14.5 \pm 1.0	14.6 \pm 1.2
22-S-448	255L 1+85 below new pipe	78.6	0.94 \pm 0.15	0.80 \pm 0.16	1.41 \pm 0.24	12.7 \pm 0.9	17.6 \pm 0.9	13.7 \pm 1.2
22-S-454	255L 1+85 above sewer	82.9	0.69 \pm 0.18	0.96 \pm 0.18	0.75 \pm 0.18	13.3 \pm 1.2	17.0 \pm 1.2	13.1 \pm 1.1
22-S-108	265L 1+85 below new pipe	79.7	0.86 \pm 0.22	0.65 \pm 0.20	0.69 \pm 0.29	10.7 \pm 1.2	14.3 \pm 1.2	7.9 \pm 1.2
22-S-443	265L 1+85 below new pipe	76.4	1.02 \pm 0.16	1.16 \pm 0.15	1.03 \pm 0.19	12.1 \pm 1.0	16.1 \pm 0.9	14.5 \pm 1.1
22-S-444	265L 1+85 after decon	81.3	0.99 \pm 0.19	1.03 \pm 0.18	1.03 \pm 0.21	14.1 \pm 1.0	12.2 \pm 1.1	13.4 \pm 1.1
*22-S-437	275L 1+85 below new pipe	73.5	BDL	0.95 \pm 0.19	0.94 \pm 0.03	14.8 \pm 1.1	13.8 \pm 1.1	17.6 \pm 0.2
22-S-433	285L 1+85 below new pipe	68.9	0.86 \pm 0.18	0.69 \pm 0.19	1.18 \pm 0.26	15.7 \pm 1.1	16.2 \pm 1.1	15.7 \pm 1.5
22-S-432	295L 1+85 Union manhole	73.1	0.72 \pm 0.17	0.76 \pm 0.16	0.80 \pm 0.22	15.5 \pm 1.1	15.8 \pm 1.1	16.2 \pm 1.3
Ave		86.0	1.11	1.04	1.23	20.0	19.0	18.3
Std dev		6.9	0.27	0.25	0.29	7.0	6.6	5.8
Max		99.3	1.89	1.68	1.88	37.4	37.2	34.4
Min		68.9	0.56	0.52	0.54	7.6	11.1	7.9
No. of Samples		70	67	63	64	75	70	70

*Samples dried and analyzed by the ACL.

oUncertainty in the counting statistics.

NA = Data Not Available.

BDL = Below Detectable Level.

TABLE D.9 Ra-226 Analyses of Final Verification Soil Samples

Sample No.	Coordinates		Grid ID	Dry Wt g	Ra-226 (186 keV)			Pb-214 (352 keV)			Bi-214 (609 keV)		
					--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
	X	Y			pCi/g $\pm \sigma$			pCi/g $\pm \sigma$			pCi/g $\pm \sigma$		
22-S-657	5R	0-45	BE-1	NA	1.85 \pm 0.53	2.35 \pm 0.85	NA	1.17 \pm 0.09	1.73 \pm 0.12	NA	1.33 \pm 0.11	1.60 \pm 0.15	NA
22-S-653	5L	0-45	CE-1	NA	BDL	1.41 \pm 0.62	NA	0.84 \pm 0.07	0.89 \pm 0.11	NA	0.82 \pm 0.09	1.10 \pm 0.12	NA
22-S-651	15L	0-45	CE-2	NA	1.67 \pm 0.72	2.91 \pm 0.99	NA	0.71 \pm 0.09	0.97 \pm 0.19	NA	0.98 \pm 0.10	0.96 \pm 0.23	NA
22-S-674	5R	0-35	BD-1	NA	2.93 \pm 0.67	2.73 \pm 0.75	NA	1.41 \pm 0.10	2.17 \pm 0.12	NA	1.52 \pm 0.12	2.46 \pm 0.15	NA
*22-S-652	5L	0-35	CD-1	94.3	3.05 \pm 0.60	5.09 \pm 0.94	NA	2.10 \pm 0.11	2.64 \pm 0.19	NA	2.07 \pm 0.12	4.05 \pm 0.22	3.77 \pm 0.05
22-S-650	15L	0-35	CD-2	NA	1.49 \pm 0.55	BDL	NA	0.66 \pm 0.08	0.99 \pm 0.18	NA	0.73 \pm 0.10	0.86 \pm 0.22	NA
22-S-643	25L	0-35	CD-3	NA	1.94 \pm 0.64	2.28 \pm 0.78	1.50 \pm 0.70	0.78 \pm 0.09	0.95 \pm 0.17	1.15 \pm 0.10	0.88 \pm 0.10	1.12 \pm 0.22	1.00 \pm 0.10
22-S-649	35L	0-35	CD-4	NA	2.86 \pm 0.59	3.12 \pm 1.00	NA	1.01 \pm 0.10	1.32 \pm 0.19	NA	1.17 \pm 0.11	1.15 \pm 0.23	NA
22-S-666	15R	0-25	BC-2	NA	BDL	BDL	NA	0.93 \pm 0.09	1.15 \pm 0.12	NA	0.87 \pm 0.11	0.76 \pm 0.14	NA
22-S-673	5R	0-25	BC-1	NA	1.51 \pm 0.66	BDL	NA	0.96 \pm 0.09	1.13 \pm 0.12	NA	1.31 \pm 0.11	1.99 \pm 0.14	NA
22-S-598	5L	0-25	CC-1	NA	BDL	1.70 \pm 0.63	NA	0.70 \pm 0.08	0.74 \pm 0.09	NA	0.69 \pm 0.09	0.78 \pm 0.09	NA
22-S-601	15L	0-25	CC-2	NA	1.32 \pm 0.59	1.48 \pm 0.68	NA	0.91 \pm 0.09	0.89 \pm 0.10	NA	0.91 \pm 0.10	0.53 \pm 0.10	NA
22-S-642	25L	0-25	CC-3	NA	1.82 \pm 0.70	2.08 \pm 0.83	1.98 \pm 0.77	1.35 \pm 0.10	1.78 \pm 0.19	1.88 \pm 0.13	1.54 \pm 0.12	2.00 \pm 0.24	2.06 \pm 0.14
22-S-646	35L	0-25	CC-4	NA	1.97 \pm 0.71	3.62 \pm 1.12	NA	1.05 \pm 0.09	1.43 \pm 0.20	NA	1.26 \pm 0.11	1.93 \pm 0.25	NA
22-S-665	15R	0-15	BB-2	NA	BDL	BDL	NA	0.92 \pm 0.09	0.88 \pm 0.13	NA	1.01 \pm 0.10	1.24 \pm 0.16	NA
22-S-656	5R	0-15	BB-1	NA	BDL	2.87 \pm 0.93	NA	0.91 \pm 0.10	0.89 \pm 0.14	NA	1.16 \pm 0.12	1.20 \pm 0.17	NA
22-S-597	5L	0-15	CB-1	NA	0.57 \pm 0.53	BDL	NA	0.81 \pm 0.08	1.01 \pm 0.10	NA	0.83 \pm 0.09	0.86 \pm 0.09	NA
22-S-600	15L	0-15	CB-2	NA	1.96 \pm 0.56	2.00 \pm 0.72	NA	0.86 \pm 0.09	1.17 \pm 0.11	NA	0.85 \pm 0.10	1.19 \pm 0.11	NA
22-S-641	25L	0-15	CB-3	NA	1.71 \pm 0.70	2.48 \pm 1.13	2.54 \pm 0.97	1.04 \pm 0.10	1.33 \pm 0.20	1.63 \pm 0.12	1.28 \pm 0.12	1.25 \pm 0.26	1.54 \pm 0.13
*22-S-645	35L	0-15	CB-4	91.9	1.96 \pm 0.71	4.10 \pm 0.91	NA	1.56 \pm 0.10	1.96 \pm 0.20	2.66 \pm 0.03	2.00 \pm 0.13	2.13 \pm 0.25	2.71 \pm 0.04
22-S-765	45L	0-15	CB-5	81.5	0.86 \pm 0.37	BDL	BDL	0.77 \pm 0.06	0.69 \pm 0.09	1.33 \pm 0.11	0.83 \pm 0.07	0.94 \pm 0.11	1.18 \pm 0.11
22-S-734	75L	0-15	CB-8	81.6	3.49 \pm 0.52	2.86 \pm 0.70	3.55 \pm 0.73	2.24 \pm 0.09	2.61 \pm 0.12	3.06 \pm 0.12	2.31 \pm 0.11	3.20 \pm 0.14	2.83 \pm 0.13
22-S-755	85L	0-15	CB-9	81.7	1.97 \pm 0.45	2.24 \pm 0.75	3.41 \pm 0.69	1.53 \pm 0.08	1.44 \pm 0.10	2.08 \pm 0.10	1.50 \pm 0.09	1.88 \pm 0.13	1.91 \pm 0.14
22-S-735	95L	0-15	CB-10	80.9	1.89 \pm 0.57	3.39 \pm 0.73	3.52 \pm 0.75	2.00 \pm 0.09	2.24 \pm 0.13	3.14 \pm 0.13	1.87 \pm 0.12	2.97 \pm 0.15	2.91 \pm 0.14
22-S-761	95L	0-15	CB-11	80.6	3.11 \pm 0.51	3.08 \pm 0.60	4.73 \pm 0.91	1.98 \pm 0.08	2.67 \pm 0.11	3.81 \pm 0.16	2.19 \pm 0.10	2.90 \pm 0.14	3.83 \pm 0.17
22-S-730	115L	0-15	CB-12	80.9	2.72 \pm 0.58	2.83 \pm 0.65	3.78 \pm 0.70	1.54 \pm 0.08	1.63 \pm 0.12	1.95 \pm 0.10	1.74 \pm 0.10	1.75 \pm 0.13	2.00 \pm 0.11
22-S-734	125L	0-15	GB-1	82.8	2.13 \pm 0.51	2.76 \pm 0.75	2.70 \pm 0.79	1.60 \pm 0.09	1.73 \pm 0.12	1.82 \pm 0.10	1.66 \pm 0.10	1.90 \pm 0.14	1.87 \pm 0.11
*22-S-751	135L	0-15	GB-2	79.9	2.80 \pm 0.49	4.32 \pm 0.73	5.17 \pm 0.73	1.51 \pm 0.11	3.15 \pm 0.14	3.85 \pm 0.14	2.68 \pm 0.13	3.75 \pm 0.17	3.72 \pm 0.15
22-S-762	145L	0-15	GB-3	79.9	2.75 \pm 0.51	4.22 \pm 0.67	NA	2.47 \pm 0.10	2.92 \pm 0.12	3.26 \pm 0.08	2.72 \pm 0.12	3.44 \pm 0.15	3.49 \pm 0.11
22-S-729	155L	0-15	GB-4	76.7	1.92 \pm 0.65	2.86 \pm 0.73	5.58 \pm 0.78	1.81 \pm 0.09	2.08 \pm 0.13	3.02 \pm 0.13	2.24 \pm 0.11	2.48 \pm 0.15	3.16 \pm 0.14
22-S-753	165L	0-15	GB-5	75.6	1.70 \pm 0.61	2.94 \pm 0.75	4.59 \pm 0.80	1.54 \pm 0.10	1.90 \pm 0.14	3.14 \pm 0.14	1.84 \pm 0.13	1.93 \pm 0.16	2.89 \pm 0.15
22-S-752	175L	0-15	GB-6	77.1	2.04 \pm 0.60	BDL	3.35 \pm 0.71	1.27 \pm 0.08	1.31 \pm 0.11	1.83 \pm 0.12	1.32 \pm 0.10	1.52 \pm 0.14	1.81 \pm 0.12

TABLE D.9 (Cont'd)

Sample No.	Coordinates		Grid ID	Dry Wt %	Ra-226 (186 keV)		Pb-214 (352 keV)		Bi-214 (609 keV)	
					--Initial--	--Aged--	--Initial--	--Aged--	--Initial--	--Aged--
	X	Y			pCi/g \pm σ	pCi/g \pm σ	pCi/g \pm σ	pCi/g \pm σ	pCi/g \pm σ	pCi/g \pm σ
22-S-664	15R	0-05	BA-2	NA	BDL	BDL	0.85 \pm 0.09	0.48 \pm 0.13	0.87 \pm 0.10	0.66 \pm 0.15
22-S-655	5R	0-05	BA-1	NA	1.93 \pm 0.68	BDL	0.82 \pm 0.09	0.94 \pm 0.13	1.02 \pm 0.11	1.75 \pm 0.15
22-S-596	5L	0-05	CA-1	NA	BDL	1.76 \pm 0.83	0.78 \pm 0.08	1.03 \pm 0.10	0.58 \pm 0.09	0.98 \pm 0.10
22-S-599	15L	0-05	CA-2	NA	1.66 \pm 0.60	2.11 \pm 0.80	0.93 \pm 0.09	1.46 \pm 0.11	1.05 \pm 0.11	1.37 \pm 0.12
22-S-640	25L	0-05	CA-3	NA	2.69 \pm 0.74	4.04 \pm 0.89	1.51 \pm 0.10	3.49 \pm 0.20	1.38 \pm 0.12	4.22 \pm 0.23
22-S-644	35L	0-05	CA-4	NA	2.83 \pm 0.72	3.35 \pm 1.02	1.36 \pm 0.10	1.83 \pm 0.20	1.34 \pm 0.13	2.37 \pm 0.26
22-S-660	45L	0-05	CA-5	NA	3.82 \pm 0.84	3.07 \pm 0.98	1.28 \pm 0.10	1.80 \pm 0.15	1.34 \pm 0.13	2.17 \pm 0.17
22-S-661	55L	0-05	CA-6	NA	3.22 \pm 0.79	3.72 \pm 0.87	1.70 \pm 0.11	2.24 \pm 0.15	1.80 \pm 0.13	2.59 \pm 0.18
*22-S-749	65L	0-05	CA-7	82.7	2.19 \pm 0.49	3.36 \pm 0.62	1.86 \pm 0.08	2.40 \pm 0.11	2.16 \pm 0.10	2.49 \pm 0.13
*22-S-742	75L	0-05	CA-8	80.0	3.27 \pm 0.64	4.42 \pm 0.84	1.81 \pm 0.09	1.77 \pm 0.12	2.14 \pm 0.11	2.03 \pm 0.14
22-S-771	85L	0-05	CA-9	85.3	1.43 \pm 0.44	2.04 \pm 0.82	1.05 \pm 0.08	1.03 \pm 0.11	1.14 \pm 0.10	1.03 \pm 0.14
22-S-770	95L	0-05	CA-10	85.8	1.32 \pm 0.61	3.35 \pm 0.83	1.58 \pm 0.10	2.03 \pm 0.13	1.94 \pm 0.12	2.55 \pm 0.16
*22-S-728	105L	0-05	CA-11	82.6	3.47 \pm 0.53	3.12 \pm 0.65	1.74 \pm 0.09	2.39 \pm 0.13	2.15 \pm 0.12	2.68 \pm 0.15
22-S-836	115L	0-05	CA-12	83.4	4.25 \pm 0.72	4.83 \pm 0.96	2.24 \pm 0.11	2.86 \pm 0.14	2.51 \pm 0.14	2.82 \pm 0.15
22-S-835	125L	0-05	CA-1	80.7	2.10 \pm 0.49	3.12 \pm 0.76	1.27 \pm 0.08	1.59 \pm 0.10	1.35 \pm 0.10	1.50 \pm 0.10
22-S-726	135L	0-05	CA-2	80.3	2.30 \pm 0.47	2.49 \pm 0.66	1.81 \pm 0.10	2.39 \pm 0.12	2.01 \pm 0.10	2.65 \pm 0.15
22-S-727	145L	0-05	CA-3	82.0	3.33 \pm 0.52	2.06 \pm 0.67	1.77 \pm 0.09	2.02 \pm 0.12	2.30 \pm 0.11	2.53 \pm 0.14
22-S-746	155L	0-05	CA-4	80.8	2.23 \pm 0.55	1.52 \pm 0.74	1.48 \pm 0.08	1.31 \pm 0.11	1.39 \pm 0.11	1.55 \pm 0.14
22-S-723	165L	0-05	CA-5	81.0	1.47 \pm 0.54	2.43 \pm 0.69	0.83 \pm 0.09	1.31 \pm 0.12	1.15 \pm 0.10	1.25 \pm 0.14
21-S-309	175L	0-05	CA-6	80.9	2.46 \pm 0.53	1.74 \pm 0.49	1.50 \pm 0.10	1.54 \pm 0.11	1.93 \pm 0.14	1.82 \pm 0.13
22-S-308	185L	0-05	CA-7	80.5	2.15 \pm 0.65	1.83 \pm 0.57	1.53 \pm 0.11	1.80 \pm 0.11	1.75 \pm 0.14	2.09 \pm 0.15
22-S-725	195L	0-05	CA-8	74.1	4.76 \pm 0.67	4.90 \pm 0.87	2.94 \pm 0.12	4.28 \pm 0.15	3.41 \pm 0.14	4.73 \pm 0.19
22-S-912	15R	0+05	AA-2	74.4	BDL	2.53 \pm 0.83	0.99 \pm 0.14	1.75 \pm 0.14	1.20 \pm 0.16	1.87 \pm 0.14
22-S-856	5R	0+05	AA-1	89.2	2.53 \pm 0.73	4.23 \pm 0.85	0.95 \pm 0.12	1.85 \pm 0.12	0.97 \pm 0.15	1.99 \pm 0.13
*22-S-815	5L	0+05	A-1	83.3	3.40 \pm 0.71	4.99 \pm 0.84	2.77 \pm 0.11	3.44 \pm 0.14	3.14 \pm 0.14	3.10 \pm 0.15
22-S-817	15L	0+05	A-2	73.0	2.93 \pm 0.56	4.09 \pm 0.75	1.40 \pm 0.09	2.82 \pm 0.13	1.68 \pm 0.11	2.64 \pm 0.14
22-S-788	25L	0+05	A-3	NA	2.20 \pm 0.52	1.53 \pm 0.64	1.31 \pm 0.08	1.53 \pm 0.12	1.62 \pm 0.10	1.62 \pm 0.14
22-S-812	35L	0+05	A-4	84.6	1.83 \pm 0.44	1.86 \pm 0.69	1.09 \pm 0.08	1.16 \pm 0.09	1.18 \pm 0.09	1.14 \pm 0.10
22-S-818	45L	0+05	A-5	86.5	2.09 \pm 0.57	4.38 \pm 0.80	1.79 \pm 0.10	2.38 \pm 0.12	2.34 \pm 0.12	2.39 \pm 0.13
22-S-544	55L	0+05	A-6	89.9	3.36 \pm 0.74	3.03 \pm 1.13	1.37 \pm 0.11	1.44 \pm 0.13	1.85 \pm 0.12	1.65 \pm 0.17
22-S-779	65L	0+05	A-7	92.3	5.05 \pm 0.73	4.20 \pm 0.92	2.96 \pm 0.13	3.46 \pm 0.16	3.41 \pm 0.15	4.04 \pm 0.19
22-S-502	75L	0+05	A-8	83.0	2.21 \pm 0.58	2.93 \pm 0.80	1.10 \pm 0.09	1.31 \pm 0.14	1.21 \pm 0.11	1.60 \pm 0.17
22-S-772	85L	0+05	A-9	86.6	BDL	1.55 \pm 0.68	1.02 \pm 0.08	1.00 \pm 0.12	1.17 \pm 0.09	1.21 \pm 0.14
22-S-767	95L	0+05	A-10	86.7	2.54 \pm 0.63	1.90 \pm 0.67	1.40 \pm 0.09	1.52 \pm 0.12	1.55 \pm 0.10	1.61 \pm 0.15
22-S-392	105L	0+05	A-11	87.8	2.81 \pm 0.76	2.26 \pm 0.66	1.28 \pm 0.11	1.90 \pm 0.12	1.50 \pm 0.14	1.84 \pm 0.14
22-S-393	115L	0+05	A-12	88.3	1.85 \pm 0.60	2.34 \pm 0.78	0.79 \pm 0.11	1.11 \pm 0.11	1.27 \pm 0.15	1.50 \pm 0.13
22-S-912	15R	0+05	AA-2	74.4	BDL	2.53 \pm 0.83	0.99 \pm 0.14	1.75 \pm 0.14	1.20 \pm 0.16	1.87 \pm 0.14
22-S-856	5R	0+05	AA-1	89.2	2.53 \pm 0.73	4.23 \pm 0.85	0.95 \pm 0.12	1.85 \pm 0.12	0.97 \pm 0.15	1.99 \pm 0.13
*22-S-815	5L	0+05	A-1	83.3	3.40 \pm 0.71	4.99 \pm 0.84	2.77 \pm 0.11	3.44 \pm 0.14	3.14 \pm 0.14	3.10 \pm 0.15
22-S-817	15L	0+05	A-2	73.0	2.93 \pm 0.56	4.09 \pm 0.75	1.40 \pm 0.09	2.82 \pm 0.13	1.68 \pm 0.11	2.64 \pm 0.14
22-S-788	25L	0+05	A-3	NA	2.20 \pm 0.52	1.53 \pm 0.64	1.31 \pm 0.08	1.53 \pm 0.12	1.62 \pm 0.10	1.62 \pm 0.14
22-S-812	35L	0+05	A-4	84.6	1.83 \pm 0.44	1.86 \pm 0.69	1.09 \pm 0.08	1.16 \pm 0.09	1.18 \pm 0.09	1.14 \pm 0.10
22-S-818	45L	0+05	A-5	86.5	2.09 \pm 0.57	4.38 \pm 0.80	1.79 \pm 0.10	2.38 \pm 0.12	2.34 \pm 0.12	2.39 \pm 0.13
22-S-544	55L	0+05	A-6	89.9	3.36 \pm 0.74	3.03 \pm 1.13	1.37 \pm 0.11	1.44 \pm 0.13	1.85 \pm 0.12	1.65 \pm 0.17
22-S-779	65L	0+05	A-7	92.3	5.05 \pm 0.73	4.20 \pm 0.92	2.96 \pm 0.13	3.46 \pm 0.16	3.41 \pm 0.15	4.04 \pm 0.19
22-S-502	75L	0+05	A-8	83.0	2.21 \pm 0.58	2.93 \pm 0.80	1.10 \pm 0.09	1.31 \pm 0.14	1.21 \pm 0.11	1.60 \pm 0.17
22-S-772	85L	0+05	A-9	86.6	BDL	1.55 \pm 0.68	1.02 \pm 0.08	1.00 \pm 0.12	1.17 \pm 0.09	1.21 \pm 0.14
22-S-767	95L	0+05	A-10	86.7	2.54 \pm 0.63	1.90 \pm 0.67	1.40 \pm 0.09	1.52 \pm 0.12	1.55 \pm 0.10	1.61 \pm 0.15
22-S-392	105L	0+05	A-11	87.8	2.81 \pm 0.76	2.26 \pm 0.66	1.28 \pm 0.11	1.90 \pm 0.12	1.50 \pm 0.14	1.84 \pm 0.14
22-S-393	115L	0+05	A-12	88.3	1.85 \pm 0.60	2.34 \pm 0.78	0.79 \pm 0.11	1.11 \pm 0.11	1.27 \pm 0.15	1.50 \pm 0.13

TABLE D.9 (Cont'd)

Sample No.	Coordinates		Grid ID	Dry Wt %	Ra-226 (186 keV)			Pb-214 (352 keV)			Bi-214 (609 keV)		
					--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
	X	Y			pCi/g $\pm \sigma$			pCi/g $\pm \sigma$			pCi/g $\pm \sigma$		
22-S-379	125L	0+05	A-13	82.8	2.85 \pm 0.59	1.29 \pm 0.60	2.48 \pm 0.82	1.20 \pm 0.09	1.45 \pm 0.10	1.61 \pm 0.14	1.68 \pm 0.13	1.92 \pm 0.12	1.72 \pm 0.16
22-S-372	135L	0+05	A-14	84.4	1.42 \pm 0.48	1.08 \pm 0.45	3.05 \pm 0.68	0.93 \pm 0.08	1.31 \pm 0.08	1.37 \pm 0.11	1.22 \pm 0.10	1.58 \pm 0.10	1.33 \pm 0.12
22-S-364	145L	0+05	A-15	83.5	2.37 \pm 0.49	1.73 \pm 0.47	3.28 \pm 0.88	0.97 \pm 0.08	1.31 \pm 0.08	1.40 \pm 0.12	1.09 \pm 0.11	1.52 \pm 0.10	1.69 \pm 0.15
22-S-864	155L	0+05	KA-1	87.2	BDL	2.78 \pm 0.64	3.08 \pm 0.90	0.59 \pm 0.11	1.14 \pm 0.09	1.43 \pm 0.12	0.75 \pm 0.14	1.01 \pm 0.11	1.66 \pm 0.12
22-S-869	165L	0+05	KA-2	87.0	BDL	1.98 \pm 0.64	2.41 \pm 0.92	0.81 \pm 0.09	0.99 \pm 0.09	1.31 \pm 0.12	1.27 \pm 0.12	1.13 \pm 0.10	1.49 \pm 0.12
22-S-872	175L	0+05	KA-3	76.4	2.20 \pm 0.86	3.40 \pm 0.72	6.72 \pm 1.09	1.08 \pm 0.12	2.78 \pm 0.12	3.83 \pm 0.19	1.45 \pm 0.14	2.29 \pm 0.13	3.59 \pm 0.19
22-S-307	185L	0+05	KA-4	79.0	2.93 \pm 0.58	2.58 \pm 0.46	5.59 \pm 0.93	1.85 \pm 0.11	2.09 \pm 0.11	4.17 \pm 0.17	2.03 \pm 0.14	2.91 \pm 0.15	3.59 \pm 0.18
22-S-305	195L	0+05	KA-5	72.5	2.23 \pm 0.63	2.58 \pm 0.75	5.50 \pm 0.11	1.30 \pm 0.10	1.69 \pm 0.10	3.83 \pm 0.19	1.30 \pm 0.15	1.97 \pm 0.14	3.80 \pm 0.20
22-S-913	15R	0+15	AB-2	77.7	2.65 \pm 0.91	5.21 \pm 0.95	7.01 \pm 1.15	0.84 \pm 0.13	1.91 \pm 0.14	2.97 \pm 0.19	1.23 \pm 0.17	1.92 \pm 0.14	3.10 \pm 0.19
22-S-926	5R	0+15	AB-1	85.9	BDL	2.60 \pm 0.70	2.47 \pm 0.77	0.62 \pm 0.11	1.31 \pm 0.10	1.94 \pm 0.13	0.57 \pm 0.12	1.24 \pm 0.11	1.89 \pm 0.13
22-S-806	5L	0+15	B-1	84.5	3.05 \pm 0.62	5.00 \pm 0.92	5.72 \pm 0.12	2.07 \pm 0.10	2.57 \pm 0.12	3.07 \pm 0.14	2.21 \pm 0.11	2.51 \pm 0.13	3.05 \pm 0.14
22-S-813	15L	0+15	B-2	85.8	2.18 \pm 0.54	3.35 \pm 0.68	5.86 \pm 1.01	1.30 \pm 0.08	1.87 \pm 0.12	3.01 \pm 0.15	1.70 \pm 0.11	1.76 \pm 0.12	2.82 \pm 0.16
22-S-820	25L	0+15	B-3	84.8	1.82 \pm 0.59	3.49 \pm 0.93	4.62 \pm 0.95	2.13 \pm 0.10	2.50 \pm 0.12	3.22 \pm 0.15	2.25 \pm 0.12	2.48 \pm 0.12	3.21 \pm 0.16
*22-S-527	35L	0+15	B-4	88.4	3.12 \pm 0.67	3.33 \pm 0.94	BDL	1.39 \pm 0.11	2.11 \pm 0.14	3.44 \pm 0.02	1.62 \pm 0.13	2.56 \pm 0.18	3.57 \pm 0.03
22-S-536	45L	0+15	B-5	89.6	1.68 \pm 0.78	3.10 \pm 0.95	BDL	0.97 \pm 0.10	1.84 \pm 0.14	1.94 \pm 0.16	1.14 \pm 0.13	2.38 \pm 0.17	2.18 \pm 0.16
22-S-789	55L	0+15	B-6	89.1	4.20 \pm 0.65	3.44 \pm 0.75	3.93 \pm 0.91	1.62 \pm 0.10	1.84 \pm 0.12	2.71 \pm 0.13	1.83 \pm 0.12	1.87 \pm 0.15	2.46 \pm 0.13
*22-S-778	65L	0+15	B-7	89.8	4.27 \pm 0.80	4.52 \pm 0.95	NA	3.21 \pm 0.13	3.65 \pm 0.17	5.55 \pm 0.05	3.44 \pm 0.16	3.63 \pm 0.21	5.65 \pm 0.07
22-S-501	75L	0+15	B-8	85.9	3.53 \pm 0.73	3.09 \pm 0.75	4.07 \pm 0.89	1.61 \pm 0.11	1.43 \pm 0.13	2.18 \pm 0.14	1.52 \pm 0.12	2.22 \pm 0.17	2.30 \pm 0.16
22-S-543	85L	0+15	B-9	91.3	2.67 \pm 0.63	2.59 \pm 0.95	BDL	1.01 \pm 0.10	1.09 \pm 0.13	1.70 \pm 0.14	1.36 \pm 0.12	1.50 \pm 0.17	1.71 \pm 0.15
22-S-475	95L	0+15	B-10	87.4	2.07 \pm 0.61	1.18 \pm 0.54	BDL	0.56 \pm 0.08	0.76 \pm 0.08	0.67 \pm 0.12	0.59 \pm 0.09	0.85 \pm 0.09	1.08 \pm 0.12
*22-S-391	105L	0+15	B-11	90.4	3.77 \pm 0.75	3.18 \pm 0.70	BDL	1.41 \pm 0.12	2.02 \pm 0.12	2.94 \pm 0.02	1.69 \pm 0.15	2.11 \pm 0.15	3.07 \pm 0.02
22-S-398	115L	0+15	B-12	90.0	2.43 \pm 0.69	2.02 \pm 0.59	2.90 \pm 1.09	1.07 \pm 0.10	1.72 \pm 0.11	2.56 \pm 0.15	1.39 \pm 0.13	1.95 \pm 0.12	2.77 \pm 0.16
22-S-380	125L	0+15	B-13	86.9	1.60 \pm 0.68	3.26 \pm 0.68	4.57 \pm 1.04	0.98 \pm 0.10	1.49 \pm 0.10	1.49 \pm 0.15	1.36 \pm 0.14	2.00 \pm 0.13	1.97 \pm 0.16
22-S-373	135L	0+15	B-14	87.5	2.34 \pm 0.60	1.16 \pm 0.54	2.16 \pm 0.85	0.76 \pm 0.09	0.82 \pm 0.07	1.27 \pm 0.12	0.75 \pm 0.11	1.08 \pm 0.10	1.08 \pm 0.13
22-S-365	145L	0+15	B-15	85.7	0.87 \pm 0.44	1.56 \pm 0.45	2.14 \pm 0.74	0.68 \pm 0.07	1.01 \pm 0.07	1.03 \pm 0.12	0.98 \pm 0.10	1.13 \pm 0.09	1.13 \pm 0.13
22-S-865	155L	0+15	KB-1	86.2	2.09 \pm 0.77	4.20 \pm 0.79	4.49 \pm 1.02	1.08 \pm 0.11	2.50 \pm 0.12	3.36 \pm 0.16	1.19 \pm 0.15	2.15 \pm 0.13	3.26 \pm 0.17
22-S-870	165L	0+15	KB-2	78.4	5.11 \pm 0.81	5.79 \pm 0.84	6.98 \pm 1.17	2.07 \pm 0.13	3.57 \pm 0.15	5.51 \pm 0.21	1.85 \pm 0.17	3.60 \pm 0.16	5.39 \pm 0.23
22-S-886	175L	0+15	KB-3	79.9	3.67 \pm 1.06	3.76 \pm 0.91	4.50 \pm 1.14	1.09 \pm 0.14	2.63 \pm 0.14	3.61 \pm 0.20	1.36 \pm 0.16	2.47 \pm 0.14	3.69 \pm 0.20
22-S-889	185L	0+15	KB-4	74.9	4.92 \pm 0.88	2.86 \pm 0.86	6.79 \pm 1.30	1.37 \pm 0.14	2.63 \pm 0.14	4.99 \pm 0.23	1.55 \pm 0.16	2.75 \pm 0.15	4.26 \pm 0.23
22-S-914	15R	0+25	AC-2	78.3	2.08 \pm 0.87	2.47 \pm 0.80	5.77 \pm 1.18	0.92 \pm 0.13	2.21 \pm 0.14	3.16 \pm 0.20	1.40 \pm 0.17	1.93 \pm 0.14	3.53 \pm 0.20
*22-S-858	5R	0+25	AG-1	88.8	5.03 \pm 0.92	5.44 \pm 1.07	NA	2.24 \pm 0.15	6.10 \pm 0.19	5.77 \pm 0.09	2.65 \pm 0.19	5.49 \pm 0.20	5.75 \pm 0.11
*22-S-574	5L	0+25	C-1	91.0	4.41 \pm 0.81	5.38 \pm 0.91	NA	2.93 \pm 0.13	5.03 \pm 0.18	7.02 \pm 0.05	3.06 \pm 0.16	5.05 \pm 0.22	7.17 \pm 0.05
22-S-927	5L	0+25	C-1	79.9	2.23 \pm 0.67	4.16 \pm 0.76	4.59 \pm 1.03	1.07 \pm 0.13	2.48 \pm 0.13	4.24 \pm 0.19	1.29 \pm 0.16	2.41 \pm 0.14	3.86 \pm 0.19
22-S-580	15L	0+25	C-2	NA	2.63 \pm 0.68	4.70 \pm 1.18	NA	1.69 \pm 0.12	3.11 \pm 0.16	NA	2.05 \pm 0.14	3.02 \pm 0.16	NA
22-S-837	25L	0+25	C-3	81.8	1.94 \pm 0.45	2.85 \pm 0.72	4.90 \pm 0.81	1.70 \pm 0.09	2.29 \pm 0.10	2.23 \pm 0.12	1.81 \pm 0.11	2.00 \pm 0.11	2.45 \pm 0.13

TABLE D.9 (Cont'd)

Sample No.	Coordinates		Grid ID	Dry Wt Z	Ra-226 (186 keV)			Pb-214 (352 keV)			Bi-214 (609 keV)		
	X	Y			--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
					pCi/g $\pm \sigma$			pCi/g $\pm \sigma$			pCi/g $\pm \sigma$		
22-S-526	35L	0+25	C-4	89.2	2.50±0.70	2.71±0.68	2.83±1.05	1.09±0.10	1.31±0.13	1.71±0.14	1.30±0.12	1.78±0.18	1.94±0.15
22-S-535	45L	0+25	C-5	86.7	2.19±0.68	3.19±0.88	4.70±1.00	1.51±0.12	1.88±0.15	2.96±0.17	1.89±0.13	2.04±0.18	2.87±0.18
22-S-546	55L	0+25	C-6	88.4	1.81±0.71	3.23±0.84	4.33±0.99	1.08±0.10	1.22±0.14	1.86±0.16	0.95±0.11	1.42±0.17	2.31±0.17
22-S-538	65L	0+25	C-7	89.3	2.57±0.66	2.58±1.14		0.72±0.09	0.60±0.13	1.15±0.13	0.95±0.11	0.71±0.17	1.40±0.14
22-S-500	75L	0+25	C-8	87.2	BDL	BDL	4.97±1.16	0.82±0.09	0.77±0.16	1.33±0.15	1.03±0.11	0.99±0.18	1.70±0.15
22-S-542	85L	0+25	C-9	88.7	2.33±0.72	2.84±0.93	1.56±0.82	0.64±0.09	0.90±0.14	1.15±0.13	0.51±0.11	0.89±0.16	0.99±0.13
22-S-780	95L	0+25	C-10	NA	1.99±0.62	2.57±0.92	NA	0.97±0.09	0.86±0.13	NA	1.30±0.11	1.13±0.16	NA
22-S-390	105L	0+25	C-11	92.9	3.48±0.69	2.43±0.69	2.82±0.92	1.20±0.12	1.76±0.12	2.14±0.16	1.60±0.11	1.90±0.14	1.98±0.16
22-S-397	115L	0+25	C-12	90.1	2.20±0.63	2.35±0.63	1.83±0.88	0.95±0.10	1.56±0.11	2.22±0.15	1.63±0.13	1.75±0.12	1.98±0.15
22-S-381	125L	0+25	C-13	86.1	1.61±0.66	2.94±0.67	2.47±0.85	0.98±0.09	1.24±0.09	1.43±0.14	1.10±0.13	1.48±0.11	1.42±0.15
22-S-374	135L	0+25	C-14	90.2	3.02±0.66	2.71±0.60	4.27±0.90	1.29±0.11	1.56±0.09	1.89±0.13	1.30±0.13	1.66±0.12	1.81±0.14
22-S-366	145L	0+25	C-15	90.0	2.21±0.58	1.68±0.64	2.48±0.86	0.96±0.09	1.05±0.10	1.44±0.12	1.07±0.12	1.25±0.10	1.37±0.13
22-S-866	155L	0+25	KC-1	84.8	2.05±0.71	4.08±0.75	3.28±0.73	1.00±0.11	2.23±0.12	2.86±0.16	1.17±0.14	2.08±0.13	2.70±0.17
*22-S-871	165L	0+25	KC-2	78.9	2.99±0.83	6.14±1.20	NA	1.83±0.15	3.58±0.17	4.63±0.08	2.10±0.18	3.21±0.16	4.33±0.09
22-S-887	175L	0+25	KC-3	75.3	3.67±0.95	3.69±0.87	4.46±1.31	1.19±0.14	1.76±0.13	2.96±0.19	1.24±0.16	1.67±0.13	2.72±0.19
*22-S-915	15R	0+35	AD-2	75.9	2.59±0.90	6.96±0.98	NA	1.28±0.15	2.73±0.15	3.95±0.10	1.26±0.17	2.34±0.15	3.83±0.12
*22-S-859	5R	0+35	AD-1	87.1	3.58±0.75	5.00±1.06	NA	1.90±0.14	4.20±0.17	5.66±0.09	2.05±0.18	4.16±0.18	5.91±0.14
22-S-575	5L	0+35	D-1	NA	3.44±0.79	2.26±0.98	4.23±0.92	0.78±0.11	2.25±0.16	2.54±0.14	1.77±0.13	2.26±0.17	2.42±0.15
22-S-581	15L	0+35	D-2	NA	0.99±0.52	2.50±0.75	NA	0.90±0.09	1.56±0.11	NA	0.93±0.10	1.81±0.12	NA
22-S-803	25L	0+35	D-3	88.3	2.53±0.59	3.03±0.73	2.47±0.81	1.67±0.09	2.35±0.12	2.02±0.11	1.74±0.11	1.91±0.12	2.03±0.13
22-S-525	35L	0+35	D-4	91.8	2.67±0.70	4.67±0.92	3.47±0.98	1.29±0.10	1.82±0.14	2.26±0.16	1.43±0.12	2.14±0.17	2.02±0.17
22-S-534	45L	0+35	D-5	90.5	BDL	2.29±0.83	3.07±1.16	0.91±0.10	1.06±0.15	1.43±0.15	1.03±0.12	0.76±0.17	1.64±0.16
22-S-547	55L	0+35	D-6	89.7	BDL	2.46±0.83	BDL	0.85±0.09	1.18±0.13	1.37±0.13	0.96±0.11	1.10±0.16	1.68±0.14
22-S-486	65L	0+35	D-7	93.8	2.65±0.67	3.09±0.74	2.92±1.04	1.10±0.10	1.64±0.11	2.48±0.15	1.22±0.13	1.84±0.14	2.66±0.17
22-S-499	75L	0+35	D-8	85.2	3.16±0.67	1.61±0.59	4.44±1.03	1.29±0.09	1.84±0.12	2.47±0.17	1.28±0.11	1.93±0.13	2.62±0.18
*22-S-541	85L	0+35	D-9	89.6	5.79±0.81	5.89±1.03	NA	2.72±0.13	4.13±0.18	2.85±0.03	3.25±0.16	4.84±0.21	3.03±0.05
22-S-471	95L	0+35	D-10	90.3	4.18±0.80	1.67±0.64	2.74±0.87	1.04±0.09	1.52±0.10	1.99±0.15	1.32±0.11	1.90±0.12	1.94±0.16
22-S-389	105L	0+35	D-11	91.5	2.17±0.72	2.33±0.72	3.87±1.01	1.00±0.11	1.62±0.11	2.15±0.15	1.32±0.14	1.90±0.12	2.26±0.16
22-S-396	115L	0+35	D-12	87.8	BDL	2.07±0.67	3.78±1.03	0.79±0.09	1.27±0.10	1.67±0.13	1.34±0.12	1.20±0.10	1.56±0.14
22-S-382	125L	0+35	D-13	85.2	2.61±0.61	2.17±0.61	2.00±0.74	0.84±0.10	1.55±0.12	1.57±0.14	1.22±0.13	1.63±0.11	1.32±0.14
22-S-375	135L	0+35	D-14	88.2	1.85±0.72	2.77±0.70	4.00±0.98	1.32±0.10	1.55±0.10	1.57±0.12	1.32±0.13	1.45±0.12	1.05±0.15
22-S-367	145L	0+35	D-15	86.0	2.79±0.58	3.03±0.58	2.79±0.93	1.44±0.09	2.07±0.10	2.43±0.15	1.60±0.12	2.35±0.13	2.29±0.16
22-S-867	155L	0+35	KD-1	89.8	3.77±0.79	2.79±0.80	3.63±1.10	1.00±0.13	3.03±0.13	2.90±0.16	1.24±0.16	1.78±0.14	2.63±0.17
22-S-919	165L	0+35	KD-2	65.0	4.30±0.83	3.78±1.06	7.70±1.66	1.24±0.15	3.18±0.16	6.65±0.30	1.70±0.19	2.75±0.17	5.70±0.32
22-S-888	175L	0+35	KD-3	76.3	2.67±0.73	3.79±0.91	6.25±1.29	1.10±0.14	2.41±0.14	4.60±0.22	1.55±0.18	2.56±0.16	3.97±0.24
22-S-891	185L	0+35	KD-4	72.9	2.42±1.04	2.58±0.93	5.07±1.19	1.07±0.14	2.29±0.14	3.67±0.21	1.32±0.18	2.17±0.15	3.42±0.23

TABLE D.9 (Cont'd)

Sample No.	Coordinates X Y	Grid ID	Dry Wt %	Ra-226 (186 keV)		Pb-214 (352 keV)		Bi-214 (609 keV)					
				--Initial--	--Aged--	--Dried--	pc/g ± σ	--Initial--	--Aged--	--Dried--	pc/g ± σ		
22-S-916	15R	0+45	AE-2	77.8	4.22±0.83	2.34±0.68	3.20±0.90	1.53±0.14	2.46±0.13	3.61±0.17	1.51±0.16	2.20±0.14	3.40±0.17
22-S-860	5R	0+45	AE-1	87.6	2.16±0.85	3.01±0.84	6.54±1.09	1.29±0.13	2.43±0.14	3.10±0.16	1.48±0.16	2.32±0.14	3.23±0.17
22-S-576	5L	0+45	E-1	NA	3.37±0.82	3.44±0.86	3.46±0.84	1.54±0.10	2.13±0.14	2.72±0.14	1.66±0.12	2.24±0.18	2.68±0.14
22-S-582	15L	0+45	E-2	NA	2.80±0.65	4.86±0.85	NA	1.43±0.10	2.58±0.14	NA	1.71±0.13	2.37±0.15	NA
22-S-826	25L	0+45	E-3	84.9	2.95±0.69	2.51±0.83	4.16±1.08	1.56±0.10	2.33±0.13	2.65±0.15	1.53±0.12	1.87±0.14	2.61±0.17
22-S-524	35L	0+45	E-4	92.4	1.97±0.79	BDL	4.77±1.04	0.82±0.10	0.81±0.13	1.09±0.14	0.83±0.11	1.04±0.17	1.21±0.14
22-S-533	45L	0+45	E-5	91.3	1.42±0.61	BDL	BDL	0.59±0.09	0.65±0.13	1.25±0.13	0.63±0.11	0.60±0.15	1.26±0.13
22-S-548	55L	0+45	E-6	88.6	2.00±0.66	BDL	BDL	0.74±0.09	1.03±0.13	1.17±0.12	0.80±0.10	1.26±0.16	1.31±0.14
22-S-487	65L	0+45	E-7	93.3	2.83±0.76	4.43±0.67	4.12±1.02	1.57±0.12	2.31±0.12	3.02±0.16	1.78±0.12	2.73±0.14	3.61±0.18
22-S-498	75L	0+45	E-8	87.6	2.99±0.77	3.48±0.80	3.43±0.98	1.26±0.11	2.16±0.13	2.75±0.17	1.46±0.11	2.32±0.16	3.07±0.19
22-S-540	85L	0+45	E-9	89.8	BDL	3.23±0.89	1.81±1.01	1.12±0.11	1.34±0.15	1.62±0.15	1.37±0.12	1.84±0.18	1.56±0.15
22-S-469	95L	0+45	E-10	89.5	1.59±0.81	2.84±0.70	4.99±1.01	1.00±0.10	1.68±0.11	1.64±0.15	1.18±0.11	1.90±0.12	1.68±0.15
22-S-388	105L	0+45	E-11	90.8	2.37±0.66	3.75±0.85	3.98±1.12	1.39±0.12	2.29±0.14	3.29±0.17	1.73±0.15	2.34±0.15	3.16±0.18
22-S-395	115L	0+45	E-12	91.2	1.67±0.66	3.20±0.71	4.40±1.14	1.25±0.11	1.91±0.12	2.76±0.17	1.74±0.14	2.15±0.14	2.60±0.17
22-S-383	125L	0+45	E-13	86.9	2.01±0.72	3.27±0.71	3.32±1.07	1.14±0.11	1.43±0.11	1.39±0.14	1.45±0.13	1.80±0.13	1.35±0.15
22-S-376	135L	0+45	E-14	84.4	3.94±0.69	3.25±0.80	3.04±1.51	1.47±0.12	2.81±0.14	2.84±0.21	1.85±0.17	2.95±0.17	3.11±0.23
22-S-368	145L	0+45	E-15	81.6	1.06±0.52	1.75±0.56	2.05±0.92	1.29±0.08	2.37±0.10	2.44±0.16	1.70±0.12	2.46±0.12	2.50±0.17
22-S-868	155L	0+45	KE-1	85.8	3.25±0.86	3.47±0.96	6.56±1.27	2.02±0.14	3.18±0.15	4.08±0.18	2.17±0.15	3.05±0.16	4.01±0.20
22-S-920	165L	0+45	KE-2	69.1	2.91±1.07	3.27±1.02	10.30±1.93	1.36±0.15	2.67±0.17	5.16±0.27	1.67±0.20	2.71±0.18	4.96±0.29
22-S-873	175L	0+45	KE-3	76.7	3.76±0.92	4.72±0.88	3.84±1.07	1.30±0.13	2.54±0.14	3.28±0.19	1.19±0.16	2.39±0.14	2.90±0.19
22-S-892	185L	0+45	KE-4	81.5	1.91±0.76	2.94±0.97	4.17±0.96	1.16±0.12	2.35±0.12	2.73±0.16	1.29±0.14	2.04±0.13	2.74±0.17
22-S-917	15R	0+55	AF-2	74.0	2.01±0.67	4.56±0.91	3.55±0.91	1.02±0.12	1.82±0.12	2.52±0.14	1.10±0.16	1.52±0.12	2.50±0.16
22-S-861	5R	0+55	AF-1	88.8	5.06±0.91	3.95±0.91	3.97±0.94	1.13±0.13	2.21±0.14	2.39±0.15	1.23±0.16	2.10±0.13	2.58±0.16
22-S-577	5L	0+55	F-1	NA	BDL	4.08±0.93	NA	1.28±0.10	1.97±0.12	NA	1.27±0.11	1.89±0.13	NA
22-S-682	15L	0+55	F-2	91.5	2.06±0.70	2.30±0.81	3.88±0.98	1.08±0.10	1.49±0.15	1.65±0.14	1.35±0.12	1.45±0.18	1.82±0.15
22-S-787	25L	0+55	F-3	NA	BDL	1.46±0.80	NA	1.83±0.11	2.06±0.13	NA	1.86±0.13	2.07±0.16	NA
22-S-523	35L	0+55	F-4	93.9	2.25±0.62	BDL	3.72±1.03	0.95±0.09	0.95±0.13	1.36±0.13	1.15±0.12	1.36±0.16	1.34±0.15
22-S-532	45L	0+55	F-5	91.1	2.63±0.67	3.06±1.05	5.00±1.12	1.85±0.13	2.20±0.17	4.28±0.20	2.28±0.15	2.40±0.20	4.38±0.20
22-S-549	55L	0+55	F-6	88.5	3.05±0.71	4.01±0.83	3.78±0.97	1.29±0.10	1.64±0.14	2.20±0.16	1.44±0.13	1.77±0.18	2.44±0.19
22-S-830	65L	0+55	F-7	83.4	0.99±0.43	2.50±0.59	BDL	0.74±0.06	0.78±0.07	1.10±0.10	0.69±0.07	0.82±0.08	0.94±0.10
22-S-681	75L	0+55	F-8	92.2	2.57±0.72	3.63±0.87	6.04±1.05	1.55±0.11	2.88±0.15	2.86±0.15	1.69±0.12	3.08±0.20	2.54±0.16
22-S-539	85L	0+55	F-9	88.4	1.88±0.71	BDL	2.85±1.06	0.92±0.10	1.31±0.14	1.40±0.14	0.80±0.12	1.41±0.17	1.17±0.15
22-S-683	95L	0+55	F-10	92.1	1.58±0.63	1.69±0.91	BDL	0.92±0.09	1.84±0.12	1.20±0.13	1.10±0.11	2.17±0.16	1.42±0.14
22-S-472	105L	0+55	F-11	85.7	3.38±0.78	2.96±0.70	3.08±0.88	1.49±0.11	1.94±0.12	2.78±0.17	1.68±0.12	2.31±0.14	2.73±0.17
22-S-394	115L	0+55	F-12	89.0	3.67±0.72	3.13±0.79	5.16±1.03	1.27±0.11	1.90±0.12	2.72±0.16	1.55±0.14	2.15±0.14	2.68±0.16
22-S-384	125L	0+55	F-13	89.6	2.04±0.67	2.82±0.72	1.96±0.81	1.33±0.10	1.73±0.11	2.66±0.17	1.47±0.15	2.11±0.14	2.53±0.17

TABLE D.9 (Cont'd)

Sample No.	Coordinates X Y	Grid ID	Dry Wt %	Ra-226 (186 keV)			Pb-214 (352 keV)			Bi-214 (609 keV)			
				--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	
													pCi/g $\pm \sigma$
22-S-377	135L	0+55	F-14	84.6	1.75 \pm 0.64	2.13 \pm 0.56	BDL	1.06 \pm 0.09	1.39 \pm 0.09	1.73 \pm 0.14	1.42 \pm 0.13	1.58 \pm 0.11	1.74 \pm 0.16
22-S-369	145L	0+55	F-15	80.0	2.80 \pm 0.55	1.31 \pm 0.55	BDL	1.09 \pm 0.08	1.68 \pm 0.09	2.06 \pm 0.14	1.49 \pm 0.10	1.90 \pm 0.11	1.95 \pm 0.14
22-S-921	155L	0+55	KF-1	86.2	BDL	1.67 \pm 0.74	3.97 \pm 0.94	1.01 \pm 0.13	1.81 \pm 0.13	2.25 \pm 0.15	1.16 \pm 0.17	1.82 \pm 0.13	2.30 \pm 0.16
22-S-895	165L	0+55	KF-2	78.7	4.16 \pm 0.82	4.67 \pm 0.90	6.04 \pm 1.53	1.82 \pm 0.13	3.12 \pm 0.15	4.56 \pm 0.21	2.51 \pm 0.17	2.70 \pm 0.15	5.05 \pm 0.24
22-S-894	175L	0+55	KF-3	74.8	5.10 \pm 1.00	8.11 \pm 1.05	NA	2.24 \pm 0.16	4.69 \pm 0.17	5.34 \pm 0.08	2.38 \pm 0.18	4.70 \pm 0.20	5.25 \pm 0.10
22-S-893	185L	0+55	KF-4	79.5	3.69 \pm 0.83	4.61 \pm 0.64	5.28 \pm 1.10	1.30 \pm 0.13	2.51 \pm 0.10	3.91 \pm 0.19	1.53 \pm 0.16	2.21 \pm 0.10	3.69 \pm 0.20
22-S-918	15R	0+65	AG-2	77.1	3.19 \pm 0.80	5.05 \pm 0.96	10.00 \pm 1.31	2.26 \pm 0.14	3.61 \pm 0.16	6.36 \pm 0.24	2.22 \pm 0.17	3.37 \pm 0.17	6.51 \pm 0.26
22-S-862	5R	0+65	AG-1	83.9	3.02 \pm 0.83	3.18 \pm 0.70	4.80 \pm 1.09	1.25 \pm 0.12	2.86 \pm 0.13	4.01 \pm 0.19	1.63 \pm 0.15	2.45 \pm 0.13	3.62 \pm 0.20
22-S-578	5L	0+65	G-1	NA	3.44 \pm 0.67	5.16 \pm 0.93	NA	1.69 \pm 0.11	3.04 \pm 0.14	NA	1.83 \pm 0.13	2.92 \pm 0.15	NA
22-S-584	15L	0+65	G-2	90.8	2.93 \pm 0.66	NA	NA	1.38 \pm 0.10	NA	2.94 \pm 0.02	1.83 \pm 0.12	NA	3.03 \pm 0.02
22-S-804	25L	0+65	G-3	89.5	2.24 \pm 0.58	4.71 \pm 0.76	4.65 \pm 0.95	1.77 \pm 0.10	1.59 \pm 0.11	2.20 \pm 0.13	2.02 \pm 0.12	1.52 \pm 0.12	2.15 \pm 0.13
22-S-522	35L	0+65	G-4	92.9	2.32 \pm 0.66	2.73 \pm 0.97	4.70 \pm 1.09	0.85 \pm 0.09	1.08 \pm 0.14	1.56 \pm 0.13	1.01 \pm 0.12	1.22 \pm 0.17	1.85 \pm 0.13
22-S-531	45L	0+65	G-5	90.1	2.36 \pm 0.61	2.29 \pm 0.87	2.95 \pm 1.02	0.92 \pm 0.09	1.19 \pm 0.14	1.65 \pm 0.14	0.88 \pm 0.11	1.47 \pm 0.17	1.74 \pm 0.14
22-S-550	55L	0+65	G-6	89.3	1.73 \pm 0.72	2.34 \pm 1.16	2.58 \pm 0.92	0.99 \pm 0.11	1.11 \pm 0.15	1.65 \pm 0.14	0.92 \pm 0.12	1.58 \pm 0.18	1.51 \pm 0.15
22-S-489	65L	0+65	G-7	92.3	3.02 \pm 0.70	BDL	2.66 \pm 1.04	1.28 \pm 0.11	1.86 \pm 0.12	2.68 \pm 0.15	1.57 \pm 0.12	2.06 \pm 0.14	3.09 \pm 0.17
22-S-476	75L	0+65	G-8	87.7	3.96 \pm 0.81	4.91 \pm 0.92	NA	1.44 \pm 0.11	1.72 \pm 0.12	2.40 \pm 0.02	1.54 \pm 0.13	1.86 \pm 0.14	2.46 \pm 0.03
22-S-498	75L	0+65	G-8	87.2	2.63 \pm 0.67	2.85 \pm 0.71	4.31 \pm 0.95	1.24 \pm 0.09	2.20 \pm 0.12	3.23 \pm 0.16	1.30 \pm 0.11	2.28 \pm 0.15	2.78 \pm 0.16
22-S-473	95L	0+65	G-9	87.1	BDL	2.39 \pm 0.64	2.85 \pm 0.94	0.77 \pm 0.09	0.90 \pm 0.09	1.19 \pm 0.14	0.76 \pm 0.10	1.10 \pm 0.11	1.21 \pm 0.14
22-S-474	105L	0+65	G-11	78.4	1.39 \pm 0.61	1.25 \pm 0.61	1.58 \pm 0.89	0.74 \pm 0.10	0.99 \pm 0.11	1.25 \pm 0.13	1.13 \pm 0.11	1.15 \pm 0.11	1.38 \pm 0.14
22-S-833	115L	0+65	G-12	85.3	1.77 \pm 0.54	BDL	1.96 \pm 0.53	0.67 \pm 0.08	0.90 \pm 0.09	0.76 \pm 0.09	0.60 \pm 0.09	0.86 \pm 0.10	0.86 \pm 0.10
22-S-385	125L	0+65	G-13	88.2	2.44 \pm 0.68	2.45 \pm 0.65	5.14 \pm 1.05	1.01 \pm 0.10	1.21 \pm 0.10	2.08 \pm 0.15	1.20 \pm 0.13	1.58 \pm 0.12	1.78 \pm 0.15
22-S-774	135L	0+65	G-14	91.1	3.02 \pm 0.73	3.94 \pm 1.11	3.60 \pm 0.93	1.99 \pm 0.11	2.33 \pm 0.16	3.59 \pm 0.18	2.42 \pm 0.14	2.69 \pm 0.19	3.28 \pm 0.18
22-S-378	135L	0+65	G-15	83.0	4.26 \pm 0.71	3.62 \pm 0.74	NA	1.70 \pm 0.12	2.63 \pm 0.13	3.64 \pm 0.03	2.25 \pm 0.16	2.55 \pm 0.15	3.79 \pm 0.04
22-S-370	145L	0+65	G-15	77.9	3.02 \pm 0.59	2.94 \pm 0.53	NA	1.65 \pm 0.10	1.96 \pm 0.11	3.53 \pm 0.04	2.26 \pm 0.14	2.36 \pm 0.12	3.60 \pm 0.05
22-S-769	145L	0+65	G-15	87.8	2.32 \pm 0.74	3.43 \pm 0.82	5.41 \pm 1.18	2.02 \pm 0.12	2.36 \pm 0.16	3.57 \pm 0.18	2.36 \pm 0.15	2.53 \pm 0.19	3.03 \pm 0.19
22-S-875	155L	0+65	KG-1	86.4	4.55 \pm 1.14	7.05 \pm 1.07	NA	2.27 \pm 0.16	4.91 \pm 0.19	4.83 \pm 0.11	2.39 \pm 0.20	4.21 \pm 0.20	4.84 \pm 0.11
22-S-896	165L	0+65	KG-2	79.7	4.05 \pm 1.01	3.75 \pm 0.84	4.49 \pm 1.13	1.79 \pm 0.14	2.47 \pm 0.16	4.13 \pm 0.20	1.91 \pm 0.16	2.70 \pm 0.16	4.23 \pm 0.21
22-S-863	5R	0+75	AH-1	76.7	2.86 \pm 0.98	6.34 \pm 0.94	NA	1.61 \pm 0.14	3.71 \pm 0.16	3.61 \pm 0.09	1.57 \pm 0.17	3.58 \pm 0.17	3.76 \pm 0.12
22-S-579	5L	0+75	H-1	NA	2.26 \pm 0.56	3.20 \pm 0.72	NA	1.23 \pm 0.09	2.14 \pm 0.12	NA	1.23 \pm 0.10	1.80 \pm 0.12	NA
22-S-724	15L	0+75	H-2	82.9	1.23 \pm 0.53	2.65 \pm 0.73	1.38 \pm 0.74	0.73 \pm 0.07	0.74 \pm 0.11	1.05 \pm 0.09	0.67 \pm 0.08	0.60 \pm 0.13	0.98 \pm 0.10
22-S-810	25L	0+7	H-3	85.3	2.04 \pm 0.60	3.75 \pm 0.80	5.64 \pm 1.00	1.64 \pm 0.10	1.94 \pm 0.12	2.97 \pm 0.17	1.83 \pm 0.12	2.16 \pm 0.13	2.79 \pm 0.16
22-S-521	35L	0+7	H-4	93.0	2.07 \pm 0.75	3.74 \pm 0.96	3.89 \pm 0.84	0.96 \pm 0.10	1.06 \pm 0.14	1.25 \pm 0.13	1.21 \pm 0.11	1.17 \pm 0.17	1.54 \pm 0.14
22-S-530	45L	0+75	H-5	92.4	BDL	1.98 \pm 0.90	NA	0.90 \pm 0.09	0.84 \pm 0.14	NA	1.23 \pm 0.11	1.32 \pm 0.17	NA
22-S-551	55L	0+75	H-6	91.5	1.94 \pm 0.74	BDL	BDL	0.74 \pm 0.10	0.80 \pm 0.13	0.98 \pm 0.13	0.93 \pm 0.11	1.56 \pm 0.16	0.86 \pm 0.14

TABLE D.9 (Cont'd)

Sample No.	Coordinates X Y	Grid ID	Dry Wt %	Ra-226 (186 keV) pCi/g \pm σ			Pb-214 (352 keV) pCi/g \pm σ			Bi-214 (609 keV) pCi/g \pm σ		
				--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
22-S-490	65L 0+75	H-7	93.0	2.15 \pm 0.63	3.93 \pm 0.78	3.80 \pm 0.91	1.27 \pm 0.10	1.58 \pm 0.11	2.18 \pm 0.14	1.40 \pm 0.12	2.03 \pm 0.14	2.10 \pm 0.15
*22-S-495	75L 0+75	H-8	88.0	2.62 \pm 0.71	4.91 \pm 0.90	NA	1.98 \pm 0.12	2.38 \pm 0.13	3.26 \pm 0.03	1.74 \pm 0.15	2.46 \pm 0.16	3.30 \pm 0.03
22-S-477	85L 0+75	H-9	89.7	2.16 \pm 0.80	BDL	BDL	0.69 \pm 0.09	0.75 \pm 0.09	0.71 \pm 0.11	0.73 \pm 0.10	0.88 \pm 0.11	0.97 \pm 0.14
22-S-468	95L 0+75	H-10	90.0	3.35 \pm 0.67	1.22 \pm 0.67	3.38 \pm 0.92	0.84 \pm 0.10	1.38 \pm 0.10	1.65 \pm 0.14	1.07 \pm 0.11	1.59 \pm 0.12	1.71 \pm 0.15
22-S-466	105L 0+75	H-11	88.5	1.34 \pm 0.65	1.38 \pm 0.64	2.15 \pm 0.86	0.67 \pm 0.09	1.15 \pm 0.10	0.98 \pm 0.12	0.67 \pm 0.10	0.95 \pm 0.11	0.89 \pm 0.13
22-S-748	115L 0+75	H-12	82.9	1.57 \pm 0.53	1.73 \pm 0.71	1.96 \pm 0.67	0.67 \pm 0.07	0.67 \pm 0.09	0.83 \pm 0.08	0.64 \pm 0.08	0.66 \pm 0.11	0.83 \pm 0.09
22-S-716	125L 0+75	H-13	90.5	BDL	2.66 \pm 0.88	2.09 \pm 0.69	0.87 \pm 0.08	0.54 \pm 0.12	1.18 \pm 0.10	1.00 \pm 0.10	1.09 \pm 0.13	1.04 \pm 0.10
*22-S-694	135L 0+75	H-14	87.5	1.71 \pm 0.64	4.73 \pm 1.24	NA	1.57 \pm 0.12	2.30 \pm 0.14	2.86 \pm 0.03	1.55 \pm 0.13	2.84 \pm 0.18	2.85 \pm 0.05
22-S-371	145L 0+75	H-15	77.9	3.01 \pm 0.62	2.58 \pm 0.63	3.02 \pm 0.76	1.41 \pm 0.09	2.24 \pm 0.11	2.08 \pm 0.15	1.68 \pm 0.12	2.64 \pm 0.13	2.21 \pm 0.15
22-S-876	155L 0+75	KH-1	78.3	3.57 \pm 0.93	4.36 \pm 1.07	3.24 \pm 0.94	1.08 \pm 0.15	2.58 \pm 0.15	3.26 \pm 0.19	0.98 \pm 0.17	2.39 \pm 0.16	3.06 \pm 0.20
22-S-897	165L 0+75	KH-2	73.6	2.87 \pm 0.70	2.02 \pm 0.92	4.44 \pm 0.95	1.05 \pm 0.12	1.72 \pm 0.11	2.38 \pm 0.13	1.54 \pm 0.15	1.66 \pm 0.12	2.22 \pm 0.14
22-S-905	5R 0+85	AJ-1	61.9	3.73 \pm 1.10	3.36 \pm 1.04	8.81 \pm 1.68	1.20 \pm 0.15	2.59 \pm 0.15	5.49 \pm 0.28	1.24 \pm 0.18	2.42 \pm 0.16	4.71 \pm 0.28
22-S-854	5L 0+85	J-1	84.2	2.86 \pm 0.69	3.86 \pm 0.78	4.94 \pm 0.99	0.91 \pm 0.12	2.10 \pm 0.12	2.99 \pm 0.17	1.24 \pm 0.15	2.20 \pm 0.14	3.02 \pm 0.18
22-S-819	15L 0+85	J-2	83.3	1.97 \pm 0.46	3.99 \pm 0.80	5.74 \pm 1.17	1.58 \pm 0.09	2.16 \pm 0.11	3.94 \pm 0.16	1.89 \pm 0.11	2.29 \pm 0.12	4.15 \pm 0.17
22-S-811	25L 0+85	J-3	85.7	2.43 \pm 0.59	3.09 \pm 0.78	4.63 \pm 1.06	1.73 \pm 0.10	2.20 \pm 0.12	2.54 \pm 0.15	1.65 \pm 0.11	1.79 \pm 0.12	2.84 \pm 0.17
22-S-821	35L 0+85	J-4	94.2	1.59 \pm 0.52	2.72 \pm 0.75	3.78 \pm 1.04	1.20 \pm 0.09	1.38 \pm 0.11	1.78 \pm 0.13	1.57 \pm 0.11	1.36 \pm 0.12	1.59 \pm 0.13
22-S-529	45L 0+85	J-5	93.8	2.32 \pm 0.67	1.97 \pm 0.75	NA	1.20 \pm 0.10	1.32 \pm 0.14	NA	1.02 \pm 0.11	1.62 \pm 0.17	NA
22-S-552	55L 0+85	J-6	91.5	1.61 \pm 0.70	BDL	2.15 \pm 0.91	0.99 \pm 0.10	1.42 \pm 0.15	1.47 \pm 0.15	0.99 \pm 0.11	1.50 \pm 0.17	1.91 \pm 0.15
22-S-491	65L 0+85	J-7	91.4	2.71 \pm 0.86	2.21 \pm 0.84	2.45 \pm 0.75	1.42 \pm 0.10	1.38 \pm 0.10	1.61 \pm 0.13	1.13 \pm 0.13	1.53 \pm 0.12	1.58 \pm 0.14
22-S-493	75L 0+85	J-8	87.5	2.68 \pm 0.64	3.09 \pm 0.71	1.86 \pm 0.83	1.19 \pm 0.10	1.59 \pm 0.11	2.31 \pm 0.15	1.52 \pm 0.12	1.79 \pm 0.13	2.33 \pm 0.15
22-S-479	85L 0+85	J-9	88.6	1.54 \pm 0.76	1.37 \pm 0.52	BDL	0.64 \pm 0.09	0.97 \pm 0.09	1.01 \pm 0.11	0.96 \pm 0.10	1.12 \pm 0.10	1.19 \pm 0.15
22-S-465	95L 0+85	J-10	90.1	1.48 \pm 0.55	BDL	BDL	0.62 \pm 0.08	0.91 \pm 0.09	0.98 \pm 0.13	0.68 \pm 0.10	1.13 \pm 0.10	1.01 \pm 0.13
22-S-467	105L 0+85	J-11	79.0	BDL	2.46 \pm 0.67	BDL	0.69 \pm 0.09	0.85 \pm 0.08	0.71 \pm 0.14	0.62 \pm 0.10	0.90 \pm 0.10	0.78 \pm 0.11
22-S-747	115L 0+85	J-12	84.2	1.71 \pm 0.52	BDL	2.76 \pm 0.70	0.65 \pm 0.07	0.48 \pm 0.09	0.76 \pm 0.08	0.71 \pm 0.08	0.72 \pm 0.11	0.70 \pm 0.09
22-S-717	125L 0+85	J-13	93.5	BDL	BDL	BDL	1.18 \pm 0.10	1.44 \pm 0.12	1.37 \pm 0.11	1.23 \pm 0.11	1.10 \pm 0.16	1.45 \pm 0.14
22-S-693	135L 0+85	J-14	91.3	BDL	BDL	BDL	1.06 \pm 0.09	1.43 \pm 0.11	1.16 \pm 0.13	1.08 \pm 0.10	1.52 \pm 0.14	1.38 \pm 0.13
22-S-690	145L 0+85	J-15	87.4	3.90 \pm 0.89	3.98 \pm 0.91	4.60 \pm 1.34	2.35 \pm 0.12	3.12 \pm 0.14	3.71 \pm 0.19	2.38 \pm 0.15	3.55 \pm 0.19	3.52 \pm 0.19
22-S-877	155L 0+85	KJ-1	83.1	BDL	5.58 \pm 0.67	4.58 \pm 1.17	1.26 \pm 0.14	2.26 \pm 0.10	3.38 \pm 0.18	1.43 \pm 0.17	2.09 \pm 0.11	3.31 \pm 0.20
22-S-898	165L 0+85	KJ-2	79.4	3.51 \pm 0.99	3.65 \pm 0.83	4.27 \pm 1.16	1.28 \pm 0.14	2.07 \pm 0.14	3.55 \pm 0.20	1.61 \pm 0.17	1.91 \pm 0.14	3.33 \pm 0.20
*22-S-906	5R 0+95	AK-1	75.9	4.55 \pm 1.08	6.12 \pm 1.03	NA	1.84 \pm 0.15	3.67 \pm 0.17	5.51 \pm 0.10	2.34 \pm 0.20	3.96 \pm 0.18	5.92 \pm 0.16
*22-S-822	5L 0+95	K-1	74.5	3.29 \pm 0.67	5.45 \pm 0.93	NA	2.99 \pm 0.13	3.79 \pm 0.16	5.29 \pm 0.08	3.41 \pm 0.15	4.07 \pm 0.17	5.23 \pm 0.09
22-S-800	15L 0+95	K-2	81.6	4.26 \pm 0.61	4.48 \pm 0.77	5.61 \pm 0.84	2.72 \pm 0.11	4.01 \pm 0.15	4.16 \pm 0.16	2.99 \pm 0.13	3.46 \pm 0.15	4.21 \pm 0.16
22-S-802	25L 0+95	K-3	85.0	3.63 \pm 0.57	3.24 \pm 0.74	4.17 \pm 0.92	2.25 \pm 0.10	2.77 \pm 0.13	2.95 \pm 0.13	2.20 \pm 0.12	3.02 \pm 0.14	3.28 \pm 0.14
22-S-801	35L 0+95	K-4	92.1	1.36 \pm 0.61	3.49 \pm 0.90	4.70 \pm 0.88	1.28 \pm 0.09	1.72 \pm 0.12	1.93 \pm 0.12	1.50 \pm 0.11	1.50 \pm 0.12	1.92 \pm 0.13
22-S-528	45L 0+95	K-5	91.6	1.51 \pm 0.63	1.55 \pm 0.72	1.90 \pm 1.01	1.03 \pm 0.10	1.29 \pm 0.13	1.57 \pm 0.14	1.28 \pm 0.12	1.62 \pm 0.17	1.89 \pm 0.14

TABLE D.9 (Cont'd)

Sample No.	Coordinates X	Y	Grid ID	Dry Wt %	Ra-226 (186 keV)			Pb-214 (352 keV)			Bi-214 (609 keV)		
					--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
					pCi/g $\pm \sigma$			pCi/g $\pm \sigma$			pCi/g $\pm \sigma$		
22-S-553	55L	0+95	K-6	88.7	1.76 \pm 0.63	BDL	4.26 \pm 1.04	1.05 \pm 0.10	1.36 \pm 0.15	2.12 \pm 0.16	1.33 \pm 0.12	1.75 \pm 0.18	2.09 \pm 0.17
22-S-592	65L	0+95	K-7	88.9	3.50 \pm 0.81	2.87 \pm 0.72	2.38 .89	0.95 \pm 0.10	1.02 \pm 0.11	1.82 \pm 0.14	0.98 \pm 0.11	1.16 \pm 0.12	1.68 \pm 0.14
22-S-834	75L	0+95	K-8	81.7	2.71 \pm 0.59	4.00 \pm 0.80	3.89 \pm 0.99	1.87 \pm 0.09	2.31 \pm 0.11	2.93 \pm 0.15	2.11 \pm 0.12	2.25 \pm 0.12	2.70 \pm 0.16
*22-S-480	85L	0+95	K-9	88.6	3.31 \pm 0.86	3.82 \pm 0.68	NA	1.35 \pm 0.11	2.05 \pm 0.12	2.25 \pm 0.03	1.77 \pm 0.13	1.77 \pm 0.14	2.34 \pm 0.04
22-S-464	95L	0+95	K-10	87.2	1.45 \pm 0.67	2.04 \pm 0.64	2.39 \pm 0.78	0.77 \pm 0.08	0.86 \pm 0.09	1.09 \pm 0.12	0.74 \pm 0.09	0.87 \pm 0.10	1.08 \pm 0.12
22-S-463	105L	0+95	K-11	85.3	1.83 \pm 0.55	BDL	1.73 \pm 0.88	0.63 \pm 0.07	0.73 \pm 0.09	0.79 \pm 0.10	0.75 \pm 0.10	0.84 \pm 0.10	0.90 \pm 0.12
22-S-638	115L	0+95	K-12	83.2	1.46 \pm 0.56	2.77 \pm 0.74	3.96 \pm 1.06	0.78 \pm 0.08	0.81 \pm 0.09	0.99 \pm 0.12	0.80 \pm 0.09	0.79 \pm 0.11	0.94 \pm 0.12
22-S-718	125L	0+95	K-13	93.8	2.04 \pm 0.54	BDL	BDL	1.01 \pm 0.08	0.92 \pm 0.11	1.37 \pm 0.10	1.13 \pm 0.10	0.93 \pm 0.14	1.27 \pm 0.11
22-S-692	135L	0+95	K-14	87.1	1.34 \pm 0.69	BDL	2.92 \pm 1.13	1.02 \pm 0.09	1.89 \pm 0.12	1.73 \pm 0.15	1.20 \pm 0.12	1.97 \pm 0.16	1.89 \pm 0.15
22-S-695	145L	0+95	K-15	87.0	1.43 \pm 0.54	2.87 \pm 0.78	5.97 \pm 1.00	1.31 \pm 0.10	2.45 \pm 0.12	2.59 \pm 0.14	1.30 \pm 0.11	2.72 \pm 0.15	2.20 \pm 0.15
22-S-878	155L	0+95	KK-1	81.5	3.68 \pm 0.86	5.07 \pm 1.01	6.94 \pm 1.21	1.68 \pm 0.15	3.99 \pm 0.16	4.51 \pm 0.21	1.65 \pm 0.17	3.27 \pm 0.17	4.20 \pm 0.22
22-S-899	165L	0+95	KK-2	78.3	2.74 \pm 0.99	2.88 \pm 0.92	3.93 \pm 1.16	1.22 \pm 0.14	2.26 \pm 0.15	2.74 \pm 0.16	1.49 \pm 0.17	2.34 \pm 0.15	2.64 \pm 0.16
*22-S-907	5R	1+05	AL-1	76.3	4.29 \pm 1.08	7.59 \pm 1.06	NA	2.53 \pm 0.16	5.41 \pm 0.20	5.14 \pm 0.13	2.81 \pm 0.19	5.31 \pm 0.21	5.14 \pm 0.16
22-S-792	5L	1+05	L-1	82.5	3.19 \pm 0.63	4.34 \pm 0.75	3.72 \pm 0.89	2.80 \pm 0.11	2.81 \pm 0.14	4.35 \pm 0.15	3.17 \pm 0.13	3.23 \pm 0.18	4.27 \pm 0.17
*22-S-805	15L	1+05	L-2	81.5	5.46 \pm 0.71	7.93 \pm 0.91	NA	3.90 \pm 0.13	5.50 \pm 0.17	6.79 \pm 0.04	4.57 \pm 0.16	5.26 \pm 0.18	7.12 \pm 0.04
22-S-807	25L	1+05	L-3	81.8	4.92 \pm 0.71	5.02 \pm 0.86	6.90 \pm 0.92	3.13 \pm 0.12	4.26 \pm 0.16	5.88 \pm 0.18	3.77 \pm 0.15	4.55 \pm 0.17	5.48 \pm 0.18
22-S-797	35L	1+05	L-4	88.6	2.11 \pm 0.60	3.54 \pm 0.77	3.39 \pm 0.70	1.55 \pm 0.10	1.95 \pm 0.11	2.22 \pm 0.12	1.65 \pm 0.11	1.81 \pm 0.12	2.16 \pm 0.12
22-S-701	45L	1+05	L-5	91.4	3.08 \pm 0.70	2.67 \pm 1.02	4.29 \pm 0.81	1.48 \pm 0.10	2.15 \pm 0.12	2.29 \pm 0.13	1.66 \pm 0.12	2.51 \pm 0.15	2.43 \pm 0.14
22-S-706	55L	1+05	L-6	88.1	2.98 \pm 0.63	3.04 \pm 0.75	1.94 \pm 0.70	1.08 \pm 0.09	1.21 \pm 0.13	1.56 \pm 0.11	1.24 \pm 0.11	1.16 \pm 0.15	1.56 \pm 0.12
22-S-823	65L	1+05	L-7	82.1	1.15 \pm 0.45	1.85 \pm 0.61	4.25 \pm 0.90	1.02 \pm 0.07	1.20 \pm 0.08	1.80 \pm 0.12	0.93 \pm 0.08	1.13 \pm 0.08	1.77 \pm 0.13
22-S-739	75L	1+05	L-8	85.2	1.25 \pm 0.51	BDL	1.57 \pm 0.71	0.68 \pm 0.08	0.74 \pm 0.11	0.88 \pm 0.09	0.87 \pm 0.09	0.91 \pm 0.12	0.92 \pm 0.09
22-S-768	85L	1+05	L-9	87.4	2.42 \pm 0.72	2.23 \pm 0.82	2.48 \pm 0.89	1.20 \pm 0.09	1.51 \pm 0.12	2.30 \pm 0.14	1.54 \pm 0.11	1.58 \pm 0.15	2.26 \pm 0.15
22-S-827	95L	1+05	L-10	83.1	1.76 \pm 0.47	3.75 \pm 0.66	5.16 \pm 1.11	1.74 \pm 0.08	2.07 \pm 0.11	3.29 \pm 0.15	2.17 \pm 0.10	1.91 \pm 0.11	3.05 \pm 0.16
22-S-829	105L	1+05	L-11	85.2	1.39 \pm 0.45	2.91 \pm 0.88	3.42 \pm 0.77	1.36 \pm 0.08	1.74 \pm 0.09	1.58 \pm 0.11	1.49 \pm 0.09	1.93 \pm 0.10	1.58 \pm 0.12
22-S-757	115L	1+05	L-12	83.5	1.52 \pm 0.40	2.53 \pm 0.74	2.19 \pm 0.51	1.17 \pm 0.07	1.29 \pm 0.10	1.25 \pm 0.09	1.17 \pm 0.08	1.24 \pm 0.11	1.21 \pm 0.09
22-S-719	125L	1+05	L-13	89.5	1.96 \pm 0.48	2.63 \pm 0.72	4.18 \pm 0.70	1.31 \pm 0.09	0.91 \pm 0.12	1.83 \pm 0.11	1.59 \pm 0.11	1.32 \pm 0.14	1.86 \pm 0.13
22-S-685	135L	1+05	L-14	84.5	1.77 \pm 0.78	1.71 \pm 0.77	5.34 \pm 1.07	1.54 \pm 0.10	2.38 \pm 0.12	2.94 \pm 0.16	1.53 \pm 0.12	2.84 \pm 0.15	2.89 \pm 0.18
22-S-696	145L	1+05	L-15	83.8	3.58 \pm 0.63	3.20 \pm 0.87	6.06 \pm 1.11	1.72 \pm 0.10	2.19 \pm 0.11	2.63 \pm 0.15	1.65 \pm 0.12	2.24 \pm 0.15	2.41 \pm 0.16
*22-S-879	155L	1+05	KL-1	87.1	3.32 \pm 0.92	4.07 \pm 1.09	NA	1.77 \pm 0.15	3.66 \pm 0.16	3.77 \pm 0.06	2.09 \pm 0.18	3.70 \pm 0.18	3.84 \pm 0.06
*22-S-922	165L	1+05	KL-2	78.9	5.44 \pm 1.04	7.43 \pm 1.16	NA	2.28 \pm 0.17	5.04 \pm 0.20	7.16 \pm 0.11	2.91 \pm 0.21	4.93 \pm 0.20	7.06 \pm 0.13
*22-S-908	5R	1+15	AM-1	75.9	4.60 \pm 0.85	7.57 \pm 1.20	NA	2.45 \pm 0.17	4.82 \pm 0.19	6.28 \pm 0.14	3.12 \pm 0.21	4.77 \pm 0.20	5.83 \pm 0.15
22-S-781	5L	1+15	M-1	NA	3.48 \pm 0.71	4.02 \pm 0.86	NA	2.31 \pm 0.12	2.76 \pm 0.17	NA	2.78 \pm 0.15	3.15 \pm 0.20	NA
*22-S-679	15L	1+15	M-2	83.1	5.48 \pm 0.87	3.63 \pm 0.78	NA	1.93 \pm 0.11	3.34 \pm 0.15	3.58 \pm 0.03	2.23 \pm 0.14	4.09 \pm 0.18	3.72 \pm 0.03
22-S-783	15L	1+15	M-2	NA	2.62 \pm 0.74	3.33 \pm 1.04	NA	2.50 \pm 0.12	2.88 \pm 0.17	NA	2.90 \pm 0.16	3.07 \pm 0.21	NA
22-S-798	25L	1+15	M-3	86.1	1.65 \pm 0.50	2.13 \pm 0.65	2.94 \pm 0.77	0.96 \pm 0.08	1.54 \pm 0.09	1.75 \pm 0.11	1.30 \pm 0.10	1.37 \pm 0.10	1.68 \pm 0.11

TABLE D.9 (Cont'd)

Sample No.	Coordinates		Grid ID	Dry Wt %	Ra-226 (186 keV)			Pb-214 (352 keV)			Bi-214 (609 keV)		
					--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
	X	Y			pCi/g $\pm \sigma$			pCi/g $\pm \sigma$			pCi/g $\pm \sigma$		
*22-S-795	35L	1+15	M-4	82.6	4.14 \pm 0.64	8.64 \pm 0.97	NA	3.11 \pm 0.12	4.21 \pm 0.15	5.33 \pm 0.04	3.71 \pm 0.15	4.03 \pm 0.16	5.49 \pm 0.05
22-S-702	45L	1+15	M-5	90.8	1.97 \pm 0.68	3.38 \pm 0.86	3.90 \pm 0.97	1.62 \pm 0.11	2.29 \pm 0.13	2.69 \pm 0.15	2.07 \pm 0.12	2.81 \pm 0.16	2.69 \pm 0.15
22-S-707	55L	1+15	M-6	91.1	3.83 \pm 0.70	2.26 \pm 1.02	3.60 \pm 0.93	1.93 \pm 0.10	1.89 \pm 0.14	2.70 \pm 0.14	2.06 \pm 0.13	2.16 \pm 0.17	2.61 \pm 0.15
22-S-712	65L	1+15	M-7	90.0	5.04 \pm 0.73	5.28 \pm 0.99	7.43 \pm 1.01	3.40 \pm 0.14	3.46 \pm 0.17	5.51 \pm 0.18	3.89 \pm 0.17	4.16 \pm 0.21	5.02 \pm 0.19
22-S-776	75L	1+15	M-8	89.2	2.73 \pm 0.67	BDL	3.28 \pm 0.84	1.14 \pm 0.10	1.04 \pm 0.14	1.61 \pm 0.14	1.37 \pm 0.12	1.18 \pm 0.17	1.84 \pm 0.14
22-S-825	85L	1+15	M-9	83.5	0.90 \pm 0.47	2.47 \pm 0.63	2.89 \pm 0.81	0.86 \pm 0.07	0.93 \pm 0.09	1.82 \pm 0.12	0.98 \pm 0.08	0.82 \pm 0.13	1.65 \pm 0.13
22-S-737	95L	1+15	M-10	81.4	1.68 \pm 0.52	BDL	1.99 \pm 0.60	0.81 \pm 0.07	1.05 \pm 0.11	1.23 \pm 0.09	1.02 \pm 0.09	0.98 \pm 0.13	1.11 \pm 0.11
22-S-731	105L	1+15	M-11	82.6	2.41 \pm 0.47	1.13 \pm 0.58	1.79 \pm 0.62	1.01 \pm 0.07	1.39 \pm 0.10	1.27 \pm 0.08	1.27 \pm 0.09	1.37 \pm 0.12	1.46 \pm 0.09
22-S-766	115L	1+15	M-12	81.5	1.62 \pm 0.49	1.41 \pm 0.68	3.34 \pm 0.87	1.36 \pm 0.08	1.22 \pm 0.10	2.28 \pm 0.13	1.57 \pm 0.09	1.61 \pm 0.12	1.96 \pm 0.14
22-S-720	125L	1+15	M-13	91.5	2.62 \pm 0.54	1.73 \pm 0.70	4.05 \pm 0.91	1.64 \pm 0.10	1.41 \pm 0.13	2.36 \pm 0.12	1.81 \pm 0.11	1.59 \pm 0.15	2.15 \pm 0.13
22-S-686	135L	1+15	M-14	85.6	3.24 \pm 0.77	3.29 \pm 0.87	7.20 \pm 1.20	1.62 \pm 0.11	3.10 \pm 0.15	3.64 \pm 0.19	1.77 \pm 0.14	3.37 \pm 0.18	3.49 \pm 0.21
22-S-697	145L	1+15	M-15	79.3	2.89 \pm 0.64	2.96 \pm 0.87	4.23 \pm 1.00	1.97 \pm 0.11	2.63 \pm 0.13	3.04 \pm 0.16	1.93 \pm 0.13	3.20 \pm 0.16	3.11 \pm 0.18
22-S-880	155L	1+15	KN-1	82.7	2.90 \pm 0.81	3.70 \pm 0.79	5.16 \pm 1.12	1.36 \pm 0.12	2.29 \pm 0.12	3.45 \pm 0.17	1.82 \pm 0.15	2.10 \pm 0.13	3.26 \pm 0.19
22-S-901	165L	1+15	KN-2	78.2	3.81 \pm 0.93	3.00 \pm 1.00	3.49 \pm 1.20	1.15 \pm 0.15	2.19 \pm 0.13	3.12 \pm 0.20	1.48 \pm 0.18	2.23 \pm 0.14	3.34 \pm 0.20
22-S-909	5R	1+25	AN-1	78.3	1.94 \pm 0.74	4.14 \pm 0.87	4.09 \pm 0.90	1.13 \pm 0.13	1.96 \pm 0.12	3.45 \pm 0.18	1.58 \pm 0.15	2.09 \pm 0.13	3.48 \pm 0.19
22-S-782	5L	1+25	N-1	NA	2.56 \pm 0.61	3.52 \pm 0.87	NA	2.73 \pm 0.11	3.17 \pm 0.14	NA	3.10 \pm 0.14	3.51 \pm 0.18	NA
22-S-832	15L	1+25	N-2	85.1	1.29 \pm 0.39	1.96 \pm 0.67	1.86 \pm 0.79	0.96 \pm 0.07	0.90 \pm 0.08	1.38 \pm 0.11	0.95 \pm 0.08	1.03 \pm 0.09	1.17 \pm 0.11
22-S-786	25L	1+25	N-3	NA	3.37 \pm 0.82	3.23 \pm 0.84	NA	3.11 \pm 0.12	3.12 \pm 0.15	NA	3.33 \pm 0.15	4.00 \pm 0.19	NA
22-S-814	35L	1+25	N-4	82.4	1.99 \pm 0.52	BDL	BDL	1.06 \pm 0.07	0.99 \pm 0.09	1.44 \pm 0.11	1.18 \pm 0.08	1.13 \pm 0.09	1.74 \pm 0.12
22-S-703	45L	1+25	N-5	90.0	1.72 \pm 0.63	2.03 \pm 0.77	2.61 \pm 0.77	1.31 \pm 0.09	1.66 \pm 0.10	1.78 \pm 0.11	1.23 \pm 0.11	1.95 \pm 0.14	1.60 \pm 0.12
*22-S-708	55L	1+25	N-6	92.2	1.33 \pm 0.61	4.16 \pm 0.92	NA	1.93 \pm 0.10	2.26 \pm 0.15	3.13 \pm 0.02	1.94 \pm 0.13	2.33 \pm 0.18	3.20 \pm 0.03
22-S-713	65L	1+25	N-7	92.2	1.88 \pm 0.69	BDL	BDL	1.04 \pm 0.09	0.83 \pm 0.12	1.39 \pm 0.11	1.09 \pm 0.10	0.80 \pm 0.16	1.11 \pm 0.12
22-S-759	75L	1+25	N-8	85.0	2.44 \pm 0.52	BDL	2.23 \pm 0.62	0.85 \pm 0.07	0.76 \pm 0.10	1.08 \pm 0.10	0.91 \pm 0.09	0.96 \pm 0.12	1.13 \pm 0.09
22-S-773	85L	1+25	N-9	88.0	1.73 \pm 0.69	1.92 \pm 0.76	3.04 \pm 0.87	1.01 \pm 0.08	1.05 \pm 0.12	1.46 \pm 0.12	1.18 \pm 0.10	0.96 \pm 0.14	1.33 \pm 0.13
22-S-745	95L	1+25	N-10	86.3	BDL	BDL	2.79 \pm 0.67	0.84 \pm 0.08	0.98 \pm 0.11	1.23 \pm 0.10	0.83 \pm 0.09	1.14 \pm 0.14	1.16 \pm 0.10
22-S-733	105L	1+25	N-11	83.2	1.46 \pm 0.41	BDL	2.13 \pm 0.68	1.06 \pm 0.07	1.20 \pm 0.11	1.63 \pm 0.11	1.11 \pm 0.09	1.43 \pm 0.13	1.64 \pm 0.10
22-S-775	115L	1+25	N-12	90.2	2.73 \pm 0.83	3.18 \pm 0.91	5.24 \pm 1.06	1.72 \pm 0.10	1.88 \pm 0.14	2.52 \pm 0.15	1.97 \pm 0.13	1.99 \pm 0.18	2.32 \pm 0.16
*22-S-721	125L	1+25	N-13	90.4	3.81 \pm 0.63	2.79 \pm 0.78	NA	1.48 \pm 0.09	1.14 \pm 0.12	1.91 \pm 0.02	1.69 \pm 0.12	1.39 \pm 0.15	1.95 \pm 0.02
22-S-687	135L	1+25	N-14	82.5	2.22 \pm 0.61	2.64 \pm 0.76	6.05 \pm 1.22	1.29 \pm 0.09	2.36 \pm 0.12	2.64 \pm 0.16	1.40 \pm 0.10	2.25 \pm 0.16	2.93 \pm 0.17
22-S-691	145L	1+25	N-15	83.5	2.92 \pm 0.67	2.70 \pm 0.79	3.42 \pm 1.00	1.58 \pm 0.10	2.22 \pm 0.12	2.11 \pm 0.15	1.74 \pm 0.12	2.78 \pm 0.15	2.36 \pm 0.16
22-S-881	155L	1+25	KN-1	81.2	BDL	4.50 \pm 0.94	6.33 \pm 1.28	1.79 \pm 0.14	2.96 \pm 0.14	4.39 \pm 0.19	1.94 \pm 0.16	2.87 \pm 0.15	4.28 \pm 0.20
22-S-902	165L	1+25	KN-2	77.4	3.35 \pm 0.90	3.71 \pm 0.88	5.53 \pm 1.25	1.33 \pm 0.14	3.00 \pm 0.15	4.08 \pm 0.21	1.37 \pm 0.18	2.68 \pm 0.16	4.43 \pm 0.22

TABLE D.9 (Cont'd)

Sample No.	Coordinates X	Grid ID	Dry Wt %	Ra-226 (186 keV)			Pb-214 (352 keV)			Bi-214 (609 keV)				
				--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--		
				pCi/g $\pm \sigma$			pCi/g $\pm \sigma$			pCi/g $\pm \sigma$			pCi/g $\pm \sigma$	
22-S-910	5R	1+35	AP-1	78.5	1.55 \pm 0.74	3.08 \pm 0.79	4.24 \pm 1.16	1.16 \pm 0.13	2.12 \pm 0.14	3.18 \pm 0.18	1.39 \pm 0.17	2.32 \pm 0.15	3.08 \pm 0.19	
22-S-808	5L	1+35	P-1	77.6	2.74 \pm 0.71	4.01 \pm 0.98	NA	2.06 \pm 0.11	2.56 \pm 0.14	NA	2.23 \pm 0.14	2.61 \pm 0.15	NA	
22-S-794	15L	1+35	P-2	85.8	4.94 \pm 0.65	4.79 \pm 0.87	6.79 \pm 0.97	3.43 \pm 0.12	4.60 \pm 0.16	5.20 \pm 0.16	3.80 \pm 0.15	4.54 \pm 0.17	5.33 \pm 0.19	
22-S-809	25L	1+35	P-3	84.9	3.81 \pm 0.66	5.96 \pm 0.89	5.65 \pm 1.01	2.49 \pm 0.11	3.19 \pm 0.13	4.36 \pm 0.17	2.75 \pm 0.13	3.23 \pm 0.14	4.36 \pm 0.18	
22-S-793	35L	1+35	P-4	81.5	0.94 \pm 0.47	2.46 \pm 0.61	2.71 \pm 0.59	0.93 \pm 0.07	1.18 \pm 0.08	1.22 \pm 0.08	1.05 \pm 0.08	1.06 \pm 0.09	1.20 \pm 0.09	
22-S-704	45L	1+35	P-5	91.1	2.80 \pm 0.67	1.77 \pm 0.76	3.49 \pm 0.78	0.94 \pm 0.08	0.91 \pm 0.11	1.69 \pm 0.12	0.99 \pm 0.10	0.94 \pm 0.13	1.49 \pm 0.12	
22-S-709	55L	1+35	P-6	92.7	2.25 \pm 0.58	2.08 \pm 0.86	2.58 \pm 0.76	1.20 \pm 0.09	1.36 \pm 0.12	1.72 \pm 0.12	1.43 \pm 0.11	1.29 \pm 0.15	1.91 \pm 0.12	
22-S-714	65L	1+35	P-7	84.9	2.15 \pm 0.68	BDL	2.75 \pm 0.84	1.32 \pm 0.10	1.06 \pm 0.14	1.43 \pm 0.12	1.31 \pm 0.12	1.21 \pm 0.16	1.60 \pm 0.12	
22-S-743	75L	1+35	P-8	83.3	3.37 \pm 0.58	2.84 \pm 0.78	6.65 \pm 0.88	2.73 \pm 0.11	2.91 \pm 0.14	4.49 \pm 0.14	3.05 \pm 0.13	3.07 \pm 0.16	4.33 \pm 0.16	
22-S-760	85L	1+35	P-9	86.6	BDL	1.58 \pm 0.68	2.31 \pm 0.76	0.94 \pm 0.08	0.96 \pm 0.10	1.54 \pm 0.11	0.90 \pm 0.09	1.14 \pm 0.13	1.12 \pm 0.13	
22-S-740	95L	1+35	P-10	83.5	2.26 \pm 0.56	BDL	2.27 \pm 0.70	1.17 \pm 0.09	1.33 \pm 0.11	1.71 \pm 0.10	1.32 \pm 0.10	1.53 \pm 0.13	1.93 \pm 0.11	
22-S-828	105L	1+35	P-11	82.8	1.25 \pm 0.50	3.00 \pm 0.74	BDL	1.31 \pm 0.08	1.55 \pm 0.10	2.04 \pm 0.13	1.42 \pm 0.09	1.52 \pm 0.10	2.03 \pm 0.14	
22-S-824	115L	1+35	P-12	81.2	2.61 \pm 0.56	3.95 \pm 0.75	4.37 \pm 1.03	1.86 \pm 0.10	2.79 \pm 0.13	2.79 \pm 0.16	2.28 \pm 0.12	2.56 \pm 0.13	2.86 \pm 0.16	
22-S-722	125L	1+35	P-13	89.4	1.34 \pm 0.57	1.80 \pm 0.82	4.05 \pm 0.73	1.27 \pm 0.10	1.09 \pm 0.12	1.73 \pm 0.11	1.43 \pm 0.11	1.35 \pm 0.15	1.66 \pm 0.12	
22-S-688	135L	1+35	P-14	87.9	2.06 \pm 0.61	2.35 \pm 0.84	3.81 \pm 0.96	1.10 \pm 0.09	1.97 \pm 0.12	2.08 \pm 0.14	1.18 \pm 0.11	2.33 \pm 0.16	1.88 \pm 0.16	
22-S-698	145L	1+35	P-15	80.8	1.71 \pm 0.64	3.97 \pm 0.87	BDL	1.84 \pm 0.13	2.36 \pm 0.15	2.98 \pm 0.18	2.14 \pm 0.14	3.42 \pm 0.19	2.56 \pm 0.18	
22-S-882	155L	1+35	KP-1	79.8	3.92 \pm 0.90	4.81 \pm 0.83	5.72 \pm 1.04	1.72 \pm 0.13	3.24 \pm 0.14	4.08 \pm 0.19	1.89 \pm 0.17	2.78 \pm 0.15	4.21 \pm 0.21	
22-S-903	165L	1+35	KP-2	79.1	3.62 \pm 0.96	BDL	7.13 \pm 1.26	1.56 \pm 0.15	3.10 \pm 0.16	4.39 \pm 0.22	1.86 \pm 0.18	3.16 \pm 0.17	4.18 \pm 0.23	
22-S-911	5R	1+45	AR-1	78.2	BDL	5.08 \pm 0.81	NA	1.13 \pm 0.12	1.58 \pm 0.12	3.12 \pm 0.05	1.20 \pm 0.16	1.58 \pm 0.12	3.30 \pm 0.08	
22-S-816	5L	1+45	R-1	85.8	1.70 \pm 0.47	2.12 \pm 0.56	5.09 \pm 0.97	1.24 \pm 0.08	1.57 \pm 0.10	2.35 \pm 0.14	1.48 \pm 0.09	1.53 \pm 0.11	2.29 \pm 0.14	
22-S-790	15L	1+45	R-2	80.6	4.06 \pm 0.70	5.57 \pm 0.85	NA	3.42 \pm 0.12	4.16 \pm 0.17	6.10 \pm 0.04	3.57 \pm 0.16	4.29 \pm 0.19	6.37 \pm 0.05	
22-S-795	25L	1+45	R-3	87.2	2.91 \pm 0.60	4.12 \pm 0.68	4.25 \pm 0.74	1.70 \pm 0.09	2.32 \pm 0.12	2.52 \pm 0.13	1.86 \pm 0.11	2.29 \pm 0.12	2.46 \pm 0.13	
22-S-799	35L	1+45	R-4	87.6	1.86 \pm 0.53	2.88 \pm 0.81	2.29 \pm 0.76	1.40 \pm 0.09	1.80 \pm 0.11	2.10 \pm 0.12	1.57 \pm 0.10	1.50 \pm 0.11	2.10 \pm 0.12	
22-S-705	45L	1+45	R-5	90.8	3.96 \pm 0.69	2.33 \pm 0.79	4.71 \pm 0.92	1.82 \pm 0.10	1.67 \pm 0.13	2.42 \pm 0.13	1.72 \pm 0.11	1.83 \pm 0.16	2.52 \pm 0.14	
22-S-710	55L	1+45	R-6	92.0	3.03 \pm 0.69	1.88 \pm 0.83	4.20 \pm 0.83	1.46 \pm 0.10	1.41 \pm 0.14	2.25 \pm 0.13	1.63 \pm 0.12	1.82 \pm 0.16	2.03 \pm 0.14	
22-S-715	65L	1+45	R-7	92.7	1.85 \pm 0.85	BDL	3.83 \pm 0.77	0.75 \pm 0.08	0.82 \pm 0.11	1.62 \pm 0.12	1.11 \pm 0.10	0.86 \pm 0.15	1.55 \pm 0.12	
22-S-744	75L	1+45	R-8	86.1	1.54 \pm 0.53	3.18 \pm 0.80	3.02 \pm 0.85	1.35 \pm 0.09	1.69 \pm 0.12	1.91 \pm 0.11	1.55 \pm 0.10	1.50 \pm 0.14	1.85 \pm 0.12	
22-S-741	85L	1+45	R-9	84.5	1.35 \pm 0.47	1.65 \pm 0.56	2.70 \pm 0.73	1.15 \pm 0.08	1.12 \pm 0.11	1.65 \pm 0.10	1.47 \pm 0.10	1.40 \pm 0.13	1.56 \pm 0.11	
22-S-732	95L	1+45	R-10	76.0	3.14 \pm 0.57	2.19 \pm 0.65	4.76 \pm 0.77	1.74 \pm 0.09	2.01 \pm 0.12	2.77 \pm 0.12	2.11 \pm 0.11	2.42 \pm 0.15	2.59 \pm 0.13	
22-S-777	105L	1+45	R-11	84.4	2.37 \pm 0.49	2.23 \pm 0.78	3.81 \pm 0.90	1.36 \pm 0.09	1.55 \pm 0.13	2.44 \pm 0.14	1.46 \pm 0.11	1.64 \pm 0.16	2.39 \pm 0.15	
22-S-831	115L	1+45	R-12	76.4	3.16 \pm 0.69	4.23 \pm 0.82	6.45 \pm 1.12	1.72 \pm 0.09	1.92 \pm 0.12	2.65 \pm 0.15	1.87 \pm 0.11	2.15 \pm 0.12	2.91 \pm 0.17	
22-S-700	125L	1+45	R-13	88.4	4.21 \pm 0.69	2.14 \pm 0.71	5.43 \pm 0.99	2.29 \pm 0.11	2.81 \pm 0.12	3.35 \pm 0.15	2.50 \pm 0.13	3.24 \pm 0.15	3.39 \pm 0.16	
22-S-689	135L	1+45	R-14	70.3	1.48 \pm 0.57	2.36 \pm 0.79	4.25 \pm 1.11	1.61 \pm 0.11	2.10 \pm 0.12	3.00 \pm 0.18	1.87 \pm 0.14	2.69 \pm 0.16	2.76 \pm 0.17	
22-S-699	145L	1+45	R-15	77.0	2.47 \pm 0.66	BDL	NA	1.40 \pm 0.11	2.21 \pm 0.13	2.65 \pm 0.03	1.59 \pm 0.13	2.70 \pm 0.17	2.71 \pm 0.04	
22-S-883	155L	1+45	KR-1	79.2	3.61 \pm 0.99	4.53 \pm 0.88	4.82 \pm 1.15	1.42 \pm 0.16	2.84 \pm 0.15	3.82 \pm 0.21	2.01 \pm 0.19	2.78 \pm 0.16	4.51 \pm 0.23	
22-S-904	165L	1+45	KR-2	75.5	BDL	4.72 \pm 1.06	2.89 \pm 1.38	1.50 \pm 0.16	2.77 \pm 0.16	4.88 \pm 0.24	1.85 \pm 0.19	2.73 \pm 0.17	4.66 \pm 0.25	
22-S-750	185L	1+45	R-19	80.6	1.40 \pm 0.46	2.18 \pm 0.70	1.88 \pm 0.68	1.63 \pm 0.08	2.06 \pm 0.11	2.38 \pm 0.10	1.68 \pm 0.10	2.18 \pm 0.13	2.23 \pm 0.12	

TABLE D.9 (Cont'd)

Sample No.	Coordinates		Grid ID	Dry Wt %	Ra-226 (186 keV)		Pb-214 (352 keV)		Bi-214 (609 keV)			
					pCi/g \pm σ		pCi/g \pm σ		pCi/g \pm σ			
					--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	--Initial--	--Aged--
22-S-669	65R	1+55	AS-7	NA	4.83 \pm 0.79	4.85 \pm 1.12	NA	2.22 \pm 0.13	3.11 \pm 0.18	2.33 \pm 0.16	3.64 \pm 0.21	NA
22-S-672	15R	1+55	AS-2	NA	1.83 \pm 0.72	3.68 \pm 0.90	NA	1.60 \pm 0.11	2.43 \pm 0.14	1.70 \pm 0.13	2.69 \pm 0.18	NA
22-S-671	5R	1+55	AS-1	NA	4.15 \pm 0.75	2.27 \pm 0.96	NA	1.59 \pm 0.12	2.23 \pm 0.15	2.11 \pm 0.14	2.42 \pm 0.20	NA
22-S-846	65L	1+55	S-7	88.8	2.13 \pm 0.60	1.55 \pm 0.65	4.99 \pm 1.03	1.41 \pm 0.11	2.09 \pm 0.11	1.95 \pm 0.12	1.59 \pm 0.12	2.57 \pm 0.15
22-S-845	75L	1+55	S-8	85.4	1.63 \pm 0.60	2.50 \pm 0.72	4.24 \pm 0.92	1.61 \pm 0.10	2.23 \pm 0.13	1.88 \pm 0.12	2.13 \pm 0.13	2.93 \pm 0.18
22-S-844	85L	1+55	S-9	85.6	3.65 \pm 0.64	4.28 \pm 0.82	6.04 \pm 1.04	2.08 \pm 0.11	2.43 \pm 0.13	2.56 \pm 0.13	2.32 \pm 0.14	3.45 \pm 0.18
22-S-843	95L	1+55	S-10	84.0	1.56 \pm 0.61	3.71 \pm 0.71	3.19 \pm 0.91	2.00 \pm 0.10	1.83 \pm 0.11	1.94 \pm 0.11	1.89 \pm 0.12	2.61 \pm 0.16
22-S-842	105L	1+55	S-11	84.5	4.56 \pm 0.62	4.58 \pm 0.94	6.68 \pm 1.03	2.56 \pm 0.11	3.43 \pm 0.14	2.94 \pm 0.13	3.35 \pm 0.15	4.27 \pm 0.18
22-S-841	115L	1+55	S-12	85.8	3.30 \pm 0.59	4.19 \pm 0.75	5.56 \pm 0.98	2.03 \pm 0.10	2.68 \pm 0.12	2.08 \pm 0.11	2.56 \pm 0.13	2.95 \pm 0.16
*22-S-675	165L	1+55	KS-2	86.3	3.35 \pm 0.67	5.09 \pm 0.80	NA	1.94 \pm 0.11	3.08 \pm 0.14	2.06 \pm 0.12	3.52 \pm 0.16	4.15 \pm 0.05
22-S-676	175L	1+55	KS-2	NA	3.95 \pm 0.64	2.84 \pm 0.90	NA	2.08 \pm 0.10	3.45 \pm 0.13	2.37 \pm 0.12	3.31 \pm 0.17	NA
22-S-677	185L	1+55	KS-4	NA	3.51 \pm 0.66	4.50 \pm 0.89	NA	1.97 \pm 0.12	3.52 \pm 0.14	2.46 \pm 0.14	4.18 \pm 0.18	NA
*22-S-839	65L	1+65	T-7	91.0	3.57 \pm 0.66	6.32 \pm 0.95	NA	1.79 \pm 0.12	2.90 \pm 0.14	1.88 \pm 0.14	2.76 \pm 0.15	3.34 \pm 0.07
22-S-840	85L	1+65	T-9	89.0	1.60 \pm 0.57	BDL	2.90 \pm 0.86	0.71 \pm 0.09	1.16 \pm 0.10	0.78 \pm 0.10	0.86 \pm 0.10	1.26 \pm 0.13
Stratford Sewer line												
*22-S-519	55L	1+75	U-6	91.7	4.14 \pm 0.63	5.46 \pm 0.87	NA	1.50 \pm 0.09	2.59 \pm 0.15	1.63 \pm 0.11	2.84 \pm 0.17	3.68 \pm 0.03
22-S-554	65L	1+75	U-7	90.5	3.03 \pm 0.67	3.51 \pm 0.73	3.56 \pm 0.93	1.33 \pm 0.10	1.92 \pm 0.13	1.53 \pm 0.10	2.31 \pm 0.16	3.29 \pm 0.17
*22-S-557	75L	1+75	U-8	89.0	1.74 \pm 0.60	4.45 \pm 0.80	NA	1.26 \pm 0.10	2.00 \pm 0.13	1.50 \pm 0.11	2.17 \pm 0.16	3.06 \pm 0.93
22-S-573	85L	1+75	U-9	NA	3.15 \pm 0.74	4.33 \pm 0.83	5.05 \pm 0.91	1.36 \pm 0.09	2.98 \pm 0.14	1.64 \pm 0.11	3.45 \pm 0.18	3.12 \pm 0.15
22-S-570	95L	1+75	U-10	NA	4.47 \pm 0.62	3.96 \pm 0.95	6.86 \pm 0.83	1.74 \pm 0.10	3.43 \pm 0.15	2.12 \pm 0.12	3.87 \pm 0.18	3.94 \pm 0.17
22-S-566	105L	1+75	U-11	90.0	3.16 \pm 0.54	3.47 \pm 0.76	4.75 \pm 0.98	1.40 \pm 0.10	1.76 \pm 0.13	1.38 \pm 0.11	2.29 \pm 0.17	3.20 \pm 0.16
22-S-571	115L	1+75	U-12	NA	5.62 \pm 0.67	5.75 \pm 0.85	7.67 \pm 0.91	1.73 \pm 0.10	3.84 \pm 0.15	2.23 \pm 0.12	4.43 \pm 0.20	4.28 \pm 0.18
22-S-572	125L	1+75	U-13	NA	3.71 \pm 0.59	3.41 \pm 0.70	4.20 \pm 0.76	1.22 \pm 0.09	2.46 \pm 0.14	1.14 \pm 0.10	2.76 \pm 0.17	3.03 \pm 0.14
*22-S-590	135L	1+75	U-14	84.3	4.20 \pm 0.62	NA	NA	2.02 \pm 0.09	NA	2.09 \pm 0.11	NA	5.36 \pm 0.06
22-S-591	145L	1+75	U-15	NA	2.70 \pm 0.46	2.56 \pm 0.64	NA	1.09 \pm 0.07	2.31 \pm 0.10	1.25 \pm 0.09	2.17 \pm 0.11	NA
22-S-592	155L	1+75	U-16	NA	1.27 \pm 0.66	3.37 \pm 0.80	NA	0.80 \pm 0.08	1.29 \pm 0.11	0.90 \pm 0.11	1.14 \pm 0.12	NA
22-S-593	165L	1+75	U-17	NA	3.56 \pm 0.77	4.76 \pm 1.07	NA	1.58 \pm 0.11	2.06 \pm 0.14	1.65 \pm 0.14	2.13 \pm 0.15	NA
22-S-594	175L	1+75	U-18	NA	2.54 \pm 0.49	3.34 \pm 0.72	NA	1.08 \pm 0.08	1.49 \pm 0.10	1.20 \pm 0.09	1.66 \pm 0.11	NA
22-S-595	185L	1+85	U-19	NA	2.50 \pm 0.58	2.18 \pm 0.75	NA	1.04 \pm 0.09	1.33 \pm 0.09	1.34 \pm 0.10	1.24 \pm 0.10	NA
22-S-604	195L	1+85	V-20	NA	BDL	1.35 \pm 0.75	NA	0.87 \pm 0.09	1.07 \pm 0.11	0.97 \pm 0.10	1.11 \pm 0.11	NA
22-S-605	205L	1+85	V-21	NA	2.77 \pm 0.69	2.88 \pm 0.72	NA	1.03 \pm 0.09	1.46 \pm 0.11	1.20 \pm 0.10	1.45 \pm 0.11	NA
22-S-606	215L	1+85	V-22	NA	2.66 \pm 0.54	3.13 \pm 0.68	NA	0.89 \pm 0.09	1.38 \pm 0.10	1.12 \pm 0.11	1.34 \pm 0.11	NA
22-S-607	225L	1+85	V-23	NA	2.43 \pm 0.61	2.52 \pm 0.70	NA	1.14 \pm 0.09	1.84 \pm 0.13	1.61 \pm 0.11	1.97 \pm 0.12	NA

TABLE D.9 (Cont'd)

Sample No.	Coordinates X Y	Grid ID	Dry Wt %	Ra-226 (186 keV)		Pb-214 (352 keV)		Bi-214 (609 keV)	
				--Initial--	--Aged--	--Initial--	--Aged--	--Initial--	--Aged--
				pCi/g $\pm \sigma$	pCi/g $\pm \sigma$	pCi/g $\pm \sigma$	pCi/g $\pm \sigma$	pCi/g $\pm \sigma$	pCi/g $\pm \sigma$
22-S-608	235L	1+85	NA	3.35 \pm 0.62	3.35 \pm 0.73	NA	NA	1.21 \pm 0.10	1.62 \pm 0.12
22-S-613	245L	1+85	NA	2.79 \pm 0.74	2.59 \pm 0.79	NA	NA	1.16 \pm 0.11	1.66 \pm 0.13
*22-S-610	255L	1+85	90.6	BDL	NA	NA	2.32 \pm 0.02	1.13 \pm 0.11	NA
22-S-614	265L	1+85	NA	1.57 \pm 0.59	2.36 \pm 0.68	NA	NA	0.90 \pm 0.09	1.10 \pm 0.10
22-S-615	275L	1+85	NA	1.34 \pm 0.53	2.83 \pm 0.80	NA	NA	0.70 \pm 0.10	1.10 \pm 0.11
22-S-616	285L	1+85	NA	3.04 \pm 0.59	1.84 \pm 0.65	NA	NA	1.15 \pm 0.11	1.48 \pm 0.11
South Parkway									
22-S-637	45L	1+85	NA	3.22 \pm 0.70	3.02 \pm 0.89	3.47 \pm 0.79	2.55 \pm 0.13	1.55 \pm 0.11	2.84 \pm 0.24
22-S-636	55L	1+85	NA	1.48 \pm 0.61	1.96 \pm 0.76	2.56 \pm 0.79	1.87 \pm 0.11	1.04 \pm 0.10	1.40 \pm 0.21
22-S-635	65L	1+85	NA	2.00 \pm 0.57	1.98 \pm 0.99	3.12 \pm 0.67	1.85 \pm 0.11	0.94 \pm 0.09	1.44 \pm 0.20
*22-S-634	75L	1+85	82.1	4.36 \pm 0.65	5.70 \pm 0.92	NA	4.62 \pm 0.03	1.77 \pm 0.10	3.13 \pm 0.23
22-S-638	85L	1+85	NA	3.15 \pm 0.63	2.88 \pm 0.86	5.28 \pm 0.89	3.30 \pm 0.14	1.93 \pm 0.11	3.30 \pm 0.23
22-S-632	105L	1+85	NA	2.98 \pm 0.52	4.53 \pm 1.15	4.88 \pm 0.91	3.69 \pm 0.14	2.34 \pm 0.12	3.40 \pm 0.24
22-S-631	115L	1+85	NA	0.97 \pm 0.51	2.40 \pm 0.63	NA	NA	1.13 \pm 0.09	1.22 \pm 0.10
22-S-630	125L	1+85	NA	3.16 \pm 0.74	4.59 \pm 0.80	NA	NA	1.49 \pm 0.11	2.55 \pm 0.13
22-S-629	135L	1+85	NA	2.65 \pm 0.62	3.79 \pm 0.81	NA	NA	1.04 \pm 0.11	2.05 \pm 0.13
Ave			85.0	2.67	3.28	4.04	2.71	1.59	2.11
Std dev			5.5	1.01	1.30	1.56	0.94	0.64	0.95
Max			94.3	5.79	8.11	10.30	7.16	4.57	5.49
Min			61.9	0.86	1.08	1.38	0.67	0.51	0.53
No. of Samples			324	362	350	265	396	396	393

*Samples dried and analyzed by the Analytical Chemistry Laboratory (ACL).

oUncertainty in the counting statistics.

NA = data not available; ACL does not report a 186 keV activity.

BDL = below detectable level.

TABLE D.10 Th-232 and K-40 Analyses of Final Verification Soil Samples

Sample No.	Coordinates X Y	Grid ID	Dry Wt %	Th-232 (911 keV) pCi/g \pm σ			K-40 (352 keV) pCi/g \pm σ		
				--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
22-S-657	5R 0-45	BE-1	NA	1.39 \pm 0.20	1.46 \pm 0.24	NA	21.2 \pm 1.3	21.2 \pm 1.6	NA
22-S-653	5L 0-45	CE-1	NA	0.84 \pm 0.17	0.73 \pm 0.24	NA	18.5 \pm 1.1	17.5 \pm 1.4	NA
22-S-651	15L 0-45	CE-2	NA	1.32 \pm 0.21	1.19 \pm 0.34	NA	23.9 \pm 1.5	22.7 \pm 2.1	NA
22-S-674	5R 0-35	BD-1	NA	1.12 \pm 0.19	1.04 \pm 0.27	NA	22.2 \pm 1.3	23.0 \pm 1.6	NA
*22-S-652	5L 0-35	CD-1	94.3	0.94 \pm 0.21	0.82 \pm 0.34	1.01 \pm 0.05	17.4 \pm 1.3	14.0 \pm 1.8	16.1 \pm 0.4
22-S-650	15L 0-35	CD-2	NA	0.97 \pm 0.21	1.25 \pm 0.34	NA	14.9 \pm 1.1	13.1 \pm 1.8	NA
22-S-643	25L 0-35	CD-3	NA	1.20 \pm 0.24	1.37 \pm 0.32	0.94 \pm 0.18	21.2 \pm 1.3	17.9 \pm 2.0	17.5 \pm 1.2
22-S-649	35L 0-35	CD-4	NA	1.78 \pm 0.22	1.49 \pm 0.21	NA	22.8 \pm 1.4	23.4 \pm 2.1	NA
22-S-666	15R 0-25	BC-2	NA	1.26 \pm 0.21	1.10 \pm 0.30	NA	18.1 \pm 1.3	25.3 \pm 1.6	NA
22-S-673	5R 0-25	BC-1	NA	1.53 \pm 0.22	1.41 \pm 0.26	NA	18.1 \pm 1.2	25.6 \pm 1.6	NA
22-S-598	5L 0-25	CC-1	NA	0.67 \pm 0.20	0.89 \pm 0.18	NA	17.0 \pm 1.3	13.6 \pm 1.0	NA
22-S-601	15L 0-25	CC-2	NA	1.09 \pm 0.21	1.32 \pm 0.17	NA	21.4 \pm 1.3	16.3 \pm 1.1	NA
22-S-642	25L 0-25	CC-3	NA	1.33 \pm 0.21	0.88 \pm 0.34	1.19 \pm 0.21	16.2 \pm 1.3	14.1 \pm 1.9	12.6 \pm 1.1
22-S-646	35L 0-25	CC-4	NA	1.24 \pm 0.22	1.15 \pm 0.38	NA	15.2 \pm 1.2	12.0 \pm 2.0	NA
22-S-665	15R 0-15	BB-2	NA	1.50 \pm 0.21	1.18 \pm 0.31	NA	17.2 \pm 1.4	13.2 \pm 1.7	NA
22-S-656	5R 0-15	BB-1	NA	1.72 \pm 0.22	1.53 \pm 0.33	NA	18.0 \pm 1.4	16.5 \pm 1.9	NA
22-S-597	5L 0-15	CB-1	NA	0.94 \pm 0.20	0.98 \pm 0.16	NA	19.3 \pm 1.2	14.2 \pm 1.1	NA
22-S-600	15L 0-15	CB-2	NA	0.91 \pm 0.20	0.99 \pm 0.18	NA	16.5 \pm 1.2	13.5 \pm 1.1	NA
22-S-641	25L 0-15	CB-3	NA	0.91 \pm 0.25	1.63 \pm 0.39	0.89 \pm 0.23	16.5 \pm 1.4	12.4 \pm 2.0	11.4 \pm 1.2
*22-S-645	35L 0-15	CB-4	91.9	0.93 \pm 0.25	1.20 \pm 0.36	1.05 \pm 0.04	17.3 \pm 1.4	15.3 \pm 2.1	15.3 \pm 0.4
22-S-765	45L 0-15	CB-5	81.5	0.88 \pm 0.16	0.78 \pm 0.19	1.45 \pm 0.20	16.3 \pm 0.9	14.8 \pm 1.2	16.4 \pm 1.1
22-S-754	75L 0-15	CB-8	81.6	1.17 \pm 0.18	1.23 \pm 0.23	0.92 \pm 0.16	13.3 \pm 0.9	14.1 \pm 1.2	12.5 \pm 0.8
22-S-755	85L 0-15	CB-9	81.7	1.15 \pm 0.16	1.21 \pm 0.20	0.74 \pm 0.15	14.8 \pm 0.9	12.1 \pm 1.3	10.3 \pm 0.8
22-S-735	95L 0-15	CB-10	80.9	0.98 \pm 0.19	0.91 \pm 0.26	0.03 \pm 0.17	17.1 \pm 1.0	18.4 \pm 1.3	11.3 \pm 0.9
22-S-761	105L 0-15	CB-11	80.6	1.10 \pm 0.16	1.08 \pm 0.19	1.44 \pm 0.22	14.0 \pm 1.0	11.3 \pm 1.1	17.0 \pm 1.1
22-S-730	115L 0-15	CB-12	80.9	0.82 \pm 0.17	1.07 \pm 0.22	0.90 \pm 0.17	20.1 \pm 1.0	15.9 \pm 1.4	11.7 \pm 0.9
22-S-734	125L 0-15	CB-1	82.8	1.29 \pm 0.18	1.48 \pm 0.24	0.98 \pm 0.18	21.1 \pm 1.1	21.4 \pm 1.4	11.0 \pm 1.0
22-S-751	135L 0-15	CB-2	79.9	0.95 \pm 0.18	1.10 \pm 0.23	0.81 \pm 0.18	13.2 \pm 1.0	12.9 \pm 1.4	11.4 \pm 0.9
*22-S-762	145L 0-15	CB-3	79.9	0.76 \pm 0.18	0.79 \pm 0.24	0.83 \pm 0.03	13.7 \pm 0.9	12.9 \pm 1.3	9.3 \pm 0.4
22-S-729	155L 0-15	CB-4	76.7	1.01 \pm 0.19	0.46 \pm 0.25	1.13 \pm 0.18	13.2 \pm 0.9	11.3 \pm 1.3	8.9 \pm 0.9
22-S-753	165L 0-15	CB-5	75.6	1.22 \pm 0.19	1.17 \pm 0.29	1.16 \pm 0.20	11.4 \pm 1.2	10.8 \pm 1.5	9.6 \pm 1.0
22-S-752	175L 0-15	CB-6	77.1	1.12 \pm 0.19	1.03 \pm 0.25	0.94 \pm 0.18	13.1 \pm 1.0	11.1 \pm 1.3	10.5 \pm 0.9

TABLE D.10 (Cont'd)

Sample No.	Coordinates X Y	Grid ID	Dry Wt %	Th-232 (911 keV) pCi/g \pm σ			K-40 (352 keV) pCi/g \pm σ		
				--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
22-S-664	15R 0-05	BA-2	NA	1.05 \pm 0.25	1.18 \pm 0.30	NA	17.8 \pm 1.3	18.0 \pm 1.7	NA
22-S-655	5R 0-05	BA-1	NA	1.25 \pm 0.22	1.72 \pm 0.31	NA	17.2 \pm 1.4	26.1 \pm 1.6	NA
22-S-596	5L 0-05	CA-1	NA	1.02 \pm 0.20	0.81 \pm 0.19	NA	20.0 \pm 1.2	14.5 \pm 1.0	NA
22-S-599	15L 0-05	CA-2	NA	1.06 \pm 0.20	0.84 \pm 0.18	NA	18.2 \pm 1.3	15.2 \pm 1.2	NA
22-S-640	25L 0-05	CA-3	NA	1.08 \pm 0.21	1.03 \pm 0.30	1.28 \pm 0.19	17.9 \pm 1.4	13.9 \pm 2.1	14.4 \pm 1.2
22-S-644	35L 0-05	CA-4	NA	1.39 \pm 0.22	0.73 \pm 0.36	NA	16.6 \pm 1.3	14.6 \pm 2.1	NA
22-S-660	45L 0-05	CA-5	NA	1.16 \pm 0.21	1.69 \pm 0.32	NA	23.6 \pm 1.5	23.1 \pm 1.8	NA
22-S-661	55L 0-05	CA-6	NA	1.59 \pm 0.22	1.31 \pm 0.30	NA	21.5 \pm 1.4	20.1 \pm 1.9	NA
*22-S-749	65L 0-05	CA-7	82.7	0.82 \pm 0.17	1.30 \pm 0.22	1.20 \pm 0.02	14.5 \pm 1.0	12.5 \pm 1.2	15.2 \pm 0.2
*22-S-742	75L 0-05	CA-8	80.0	0.85 \pm 0.17	1.10 \pm 0.22	1.12 \pm 0.03	15.3 \pm 1.1	15.9 \pm 1.4	17.4 \pm 0.2
22-S-771	85L 0-05	CA-9	85.3	1.80 \pm 0.18	1.30 \pm 0.25	1.28 \pm 0.24	20.8 \pm 1.2	18.5 \pm 1.5	19.7 \pm 1.4
22-S-770	95L 0-05	CA-10	85.8	1.12 \pm 0.20	0.89 \pm 0.26	1.18 \pm 0.26	15.3 \pm 1.2	15.8 \pm 1.5	16.4 \pm 1.2
*22-S-728	105L 0-05	CA-11	82.6	1.03 \pm 0.17	1.24 \pm 0.26	1.26 \pm 0.03	18.2 \pm 1.1	16.7 \pm 1.5	18.5 \pm 0.2
22-S-836	115L 0-05	CA-12	83.4	1.29 \pm 0.20	1.21 \pm 0.21	0.57 \pm 0.26	19.0 \pm 1.4	16.5 \pm 1.2	20.8 \pm 1.4
22-S-835	125L 0-05	GA-1	80.7	1.14 \pm 0.18	1.13 \pm 0.19	1.56 \pm 0.21	16.0 \pm 1.1	13.8 \pm 0.9	16.1 \pm 1.2
22-S-726	135L 0-05	GA-2	80.3	1.19 \pm 0.17	0.93 \pm 0.23	1.11 \pm 0.16	15.0 \pm 1.1	12.9 \pm 1.3	13.9 \pm 0.8
22-S-727	145L 0-05	GA-3	82.0	1.23 \pm 0.18	0.61 \pm 0.24	0.85 \pm 0.18	15.1 \pm 1.0	15.4 \pm 1.3	11.9 \pm 0.9
22-S-746	155L 0-05	GA-4	80.8	1.08 \pm 0.18	1.21 \pm 0.24	1.19 \pm 0.17	13.7 \pm 1.0	12.5 \pm 1.3	12.1 \pm 0.9
22-S-723	165L 0-05	GA-5	81.0	1.14 \pm 0.19	0.61 \pm 0.25	1.21 \pm 0.17	15.6 \pm 1.1	13.4 \pm 1.4	14.4 \pm 1.0
22-S-309	175L 0-05	GA-6	80.9	1.47 \pm 0.30	1.29 \pm 0.25	0.91 \pm 0.23	21.8 \pm 1.8	16.2 \pm 1.7	13.7 \pm 1.2
22-S-308	185L 0-05	GA-7	80.5	1.51 \pm 0.27	1.41 \pm 0.26	1.76 \pm 0.26	19.4 \pm 1.8	14.1 \pm 1.7	15.1 \pm 1.3
22-S-725	195L 0-05	GA-8	74.1	1.08 \pm 0.21	1.16 \pm 0.26	0.89 \pm 0.20	11.2 \pm 1.0	11.9 \pm 1.4	9.5 \pm 0.9
22-S-912	15R 0+05	AA-2	74.4	0.58 \pm 0.32	1.33 \pm 0.19	1.50 \pm 0.29	14.2 \pm 1.8	10.0 \pm 1.1	18.4 \pm 1.6
22-S-856	5R 0+05	AA-1	89.2	1.63 \pm 0.29	1.29 \pm 0.21	1.63 \pm 0.23	22.2 \pm 1.7	18.5 \pm 1.2	23.3 \pm 1.4
*22-S-815	5L 0+05	A-1	83.3	1.60 \pm 0.19	1.07 \pm 0.18	1.37 \pm 0.02	10.7 \pm 1.1	12.9 \pm 1.0	18.5 \pm 0.1
22-S-817	15L 0+05	A-2	73.0	0.63 \pm 0.17	0.71 \pm 0.18	1.09 \pm 0.21	10.3 \pm 1.1	8.5 \pm 0.9	16.6 \pm 1.2
22-S-788	25L 0+05	A-3	NA	0.90 \pm 0.19	1.03 \pm 0.25	NA	15.8 \pm 1.1	14.5 \pm 1.4	NA
22-S-812	35L 0+05	A-4	84.6	1.48 \pm 0.17	0.85 \pm 0.20	1.14 \pm 0.24	18.1 \pm 1.0	12.4 \pm 0.9	18.9 \pm 1.2
22-S-818	45L 0+05	A-5	86.5	1.40 \pm 0.19	1.53 \pm 0.19	1.53 \pm 0.26	23.7 \pm 0.1	17.5 \pm 1.0	21.3 \pm 1.2
22-S-544	55L 0+05	A-6	89.9	1.57 \pm 0.26	1.87 \pm 0.30	1.29 \pm 0.26	30.4 \pm 1.4	23.8 \pm 1.8	23.9 \pm 1.4
22-S-779	65L 0+05	A-7	92.3	1.76 \pm 0.22	1.56 \pm 0.33	1.42 \pm 0.24	27.7 \pm 1.5	23.5 \pm 1.9	22.5 \pm 1.3
22-S-502	75L 0+05	A-8	83.0	1.30 \pm 0.20	0.86 \pm 0.33	1.29 \pm 0.24	23.1 \pm 1.3	20.1 \pm 1.9	19.4 \pm 1.4
22-S-772	85L 0+05	A-9	86.6	1.14 \pm 0.19	1.02 \pm 0.25	1.08 \pm 0.22	18.5 \pm 1.1	13.7 \pm 1.5	16.5 \pm 1.2
22-S-767	95L 0+05	A-10	86.7	1.10 \pm 0.19	0.56 \pm 0.25	1.32 \pm 0.25	21.8 \pm 1.3	19.1 \pm 1.6	23.1 \pm 1.3
22-S-392	105L 0+05	A-11	87.8	1.84 \pm 0.28	1.26 \pm 0.23	1.21 \pm 0.25	28.9 \pm 1.9	20.2 \pm 1.4	18.2 \pm 1.4
22-S-393	115L 0+05	A-12	88.3	2.08 \pm 0.31	0.61 \pm 0.25	1.52 \pm 0.27	26.7 \pm 2.1	19.7 \pm 1.5	16.6 \pm 1.5

TABLE D.10 (Cont'd)

Sample No.	Coordinates		Grid ID	Dry Wt %	Th-232 (911 keV)			K-40 (352 keV)		
	X	Y			--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
					pCi/g $\pm \sigma$			pCi/g $\pm \sigma$		
22-S-379	125L	0+05	A-13	82.8	1.50±0.27	1.08±0.18	0.81±0.27	20.5±1.7	18.3±1.2	11.8±1.2
22-S-372	135L	0+05	A-14	84.4	1.59±0.21	0.85±0.17	1.01±0.20	19.7±1.5	14.6±1.0	16.0±1.1
22-S-364	145L	0+05	A-15	83.5	1.86±0.25	0.86±0.18	1.27±0.20	26.7±1.7	18.5±1.2	18.9±1.2
22-S-864	155L	0+05	KA-1	87.2	0.63±0.25	0.90±0.17	1.31±0.23	12.8±1.4	10.9±0.9	13.8±1.1
22-S-869	165L	0+05	KA-2	87.0	0.51±0.22	1.00±0.19	1.08±0.21	13.1±1.4	10.9±0.9	12.9±1.0
22-S-872	175L	0+05	KA-3	76.4	0.88±0.23	0.90±0.19	1.14±0.26	12.3±1.4	9.7±0.9	15.5±1.4
22-S-307	185L	0+05	KA-4	79.0	1.40±0.25	0.88±0.24	1.35±0.24	18.9±1.6	17.9±1.5	16.1±1.2
22-S-305	195L	0+05	KA-5	72.5	0.76±0.27	0.65±0.25	1.10±0.27	17.5±1.7	13.9±1.6	15.9±1.4
22-S-913	15R	0+15	AB-2	77.7	1.39±0.31	0.81±0.21	1.61±0.27	12.2±1.8	11.7±1.2	18.0±1.6
22-S-926	5R	0+15	AB-1	85.9	0.55±0.24	0.82±0.17	1.00±0.19	13.5±1.4	10.3±0.9	12.6±1.1
22-S-806	5L	0+15	B-1	84.5	1.53±0.19	0.84±0.20	1.22±0.19	21.9±1.1	17.8±1.1	16.9±1.1
22-S-813	15L	0+15	B-2	85.8	1.06±0.18	1.09±0.19	1.40±0.24	20.6±1.2	16.5±1.0	18.6±1.3
22-S-820	25L	0+15	B-3	84.8	1.28±0.17	1.19±0.19	1.37±0.22	20.6±1.0	14.0±0.9	16.0±1.2
*22-S-527	35L	0+15	B-4	88.4	1.72±0.22	1.75±0.31	1.40±0.03	26.3±1.4	19.9±1.3	18.9±0.2
22-S-536	45L	0+15	B-5	89.6	1.34±0.27	1.65±0.35	0.79±0.28	25.0±1.6	35.3±2.0	22.0±1.5
22-S-789	55L	0+15	B-6	89.1	1.14±0.22	1.90±0.26	1.27±0.20	22.1±1.3	24.9±1.7	23.6±1.2
*22-S-778	65L	0+15	B-7	89.8	0.98±0.21	2.24±0.31	0.95±0.06	24.6±1.3	18.5±1.9	18.0±0.4
22-S-501	75L	0+15	B-8	85.9	1.41±0.24	0.65±0.29	1.12±0.22	29.1±1.6	21.7±1.8	19.7±1.3
22-S-543	85L	0+15	B-9	91.3	1.38±0.24	1.00±0.34	1.46±0.27	34.7±1.6	25.4±2.0	26.3±1.6
22-S-475	95L	0+15	B-10	87.4	1.05±0.21	1.56±0.19	1.39±0.25	19.2±1.3	24.3±1.2	18.5±1.3
*22-S-391	105L	0+15	B-11	90.4	2.21±0.32	1.53±0.24	1.29±0.03	32.2±2.2	21.9±1.5	19.8±0.2
22-S-398	115L	0+15	B-12	90.0	1.73±0.29	1.14±0.22	1.35±0.22	34.0±2.0	21.9±1.4	20.9±1.4
22-S-380	125L	0+15	B-13	86.9	1.39±0.30	1.30±0.23	1.28±0.28	33.3±2.2	27.2±1.4	21.2±1.5
22-S-373	135L	0+15	B-14	87.5	1.74±0.25	1.27±0.19	1.14±0.22	32.0±1.8	18.6±1.3	17.8±1.2
22-S-365	145L	0+15	B-15	85.7	1.31±0.24	1.17±0.18	1.46±0.23	26.7±1.5	17.5±1.1	16.8±1.3
22-S-865	155L	0+15	KB-1	86.2	1.28±0.25	0.95±0.18	1.07±0.26	16.6±1.6	13.4±0.1	18.3±1.3
22-S-870	165L	0+15	KB-2	78.4	0.95±0.28	1.02±0.22	0.97±0.28	10.4±1.6	11.6±1.0	16.7±1.4
22-S-886	175L	0+15	KB-3	79.9	1.28±0.29	1.37±0.20	1.01±0.26	11.9±1.6	11.7±1.0	14.2±1.4
22-S-889	185L	0+15	KB-4	74.9	1.17±0.30	1.07±0.20	1.23±0.29	12.7±1.8	14.1±1.1	18.3±1.5
22-S-914	15R	0+25	AC-2	78.3	0.83±0.28	1.17±0.21	1.78±0.25	11.2±1.7	10.7±1.0	15.8±1.4
*22-S-858	5R	0+25	AC-1	88.8	1.56±0.30	1.39±0.25	1.60±0.16	16.6±1.7	15.1±1.2	14.4±0.9
*22-S-574	5L	0+25	C-1	91.0	1.20±0.23	1.10±0.35	1.34±0.04	17.4±1.4	17.4±1.9	16.4±0.2
22-S-927	5L	0+25	C-1	79.9	1.33±0.24	0.89±0.20	1.06±0.24	23.0±1.5	11.5±1.0	14.2±1.3
22-S-580	15L	0+25	C-2	NA	1.94±0.25	1.56±0.21	NA	23.7±1.5	17.8±1.4	NA
22-S-837	25L	0+25	C-3	81.8	1.43±0.16	1.33±0.16	1.18±0.20	15.7±0.9	13.5±0.9	16.3±1.1

TABLE D.10 (Cont'd)

Sample No.	Coordinates		Grid ID	Dry Wt %	Th-232 (911 keV)			K-40 (352 keV)		
	X	Y			--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
					pCi/g \pm σ			pCi/g \pm σ		
22-S-526	35L	0+25	C-4	89.2	1.12 \pm 0.22	0.94 \pm 0.33	1.36 \pm 0.27	33.3 \pm 1.6	23.2 \pm 2.0	23.9 \pm 1.6
22-S-535	45L	0+25	C-5	86.7	1.31 \pm 0.24	1.43 \pm 0.31	1.31 \pm 0.28	28.4 \pm 1.6	29.6 \pm 2.0	27.4 \pm 1.5
22-S-546	55L	0+25	C-6	88.4	1.34 \pm 0.24	0.89 \pm 0.33	1.06 \pm 0.25	26.9 \pm 1.4	20.3 \pm 1.9	21.7 \pm 1.5
22-S-538	65L	0+25	C-7	89.3	BDL	0.71 \pm 0.30	0.95 \pm 0.26	18.9 \pm 1.5	21.4 \pm 2.0	19.9 \pm 1.5
22-S-500	75L	0+25	C-8	87.2	1.23 \pm 0.23	1.32 \pm 0.35	1.77 \pm 0.28	24.1 \pm 1.5	22.9 \pm 2.1	24.4 \pm 1.6
22-S-542	85L	0+25	C-9	88.7	1.36 \pm 0.24	1.21 \pm 0.32	1.13 \pm 0.27	27.0 \pm 1.5	21.6 \pm 1.9	20.5 \pm 1.5
22-S-780	95L	0+25	C-10	NA	1.23 \pm 0.21	1.32 \pm 0.31	NA	30.0 \pm 1.4	30.5 \pm 1.9	NA
22-S-390	105L	0+25	C-11	92.9	2.39 \pm 0.33	1.37 \pm 0.25	1.28 \pm 0.25	44.1 \pm 2.6	30.7 \pm 1.7	24.9 \pm 1.6
22-S-397	115L	0+25	C-12	90.1	1.42 \pm 0.27	1.07 \pm 0.23	1.37 \pm 0.25	37.5 \pm 2.1	27.6 \pm 1.6	27.0 \pm 1.4
22-S-381	125L	0+25	C-13	86.1	1.19 \pm 0.25	1.35 \pm 0.20	1.15 \pm 0.24	29.1 \pm 2.0	23.8 \pm 1.4	17.1 \pm 1.4
22-S-374	135L	0+25	C-14	90.2	2.11 \pm 0.28	1.34 \pm 0.20	1.18 \pm 0.24	42.4 \pm 2.1	27.6 \pm 1.5	27.5 \pm 1.5
22-S-366	145L	0+25	C-15	90.0	1.72 \pm 0.24	1.20 \pm 0.21	1.53 \pm 0.25	36.0 \pm 2.1	24.2 \pm 1.4	22.2 \pm 1.4
22-S-866	155L	0+25	KC-1	84.8	1.35 \pm 0.27	1.31 \pm 0.20	1.17 \pm 0.23	15.8 \pm 1.5	15.7 \pm 1.0	17.5 \pm 1.3
*22-S-871	165L	0+25	KC-2	78.9	0.53 \pm 0.28	1.18 \pm 0.19	1.31 \pm 0.12	17.2 \pm 1.7	14.3 \pm 1.1	17.7 \pm 0.7
22-S-887	175L	0+25	KC-3	75.3	0.44 \pm 0.29	1.09 \pm 0.22	1.45 \pm 0.30	11.3 \pm 1.7	11.7 \pm 1.1	15.6 \pm 1.5
*22-S-915	15R	0+35	AD-2	75.9	0.58 \pm 0.33	1.05 \pm 0.20	1.54 \pm 0.16	12.1 \pm 1.7	10.6 \pm 0.1	16.7 \pm 0.9
*22-S-859	5R	0+35	AD-1	87.1	1.08 \pm 0.29	0.53 \pm 0.23	1.34 \pm 0.14	11.5 \pm 1.7	14.6 \pm 1.2	13.6 \pm 1.0
22-S-575	5L	0+35	D-1	NA	0.96 \pm 0.24	1.29 \pm 0.30	1.15 \pm 0.22	20.5 \pm 1.4	14.9 \pm 1.8	14.7 \pm 1.2
22-S-581	15L	0+35	D-2	NA	1.41 \pm 0.21	1.09 \pm 0.21	NA	18.1 \pm 1.2	16.1 \pm 1.0	NA
22-S-803	25L	0+35	D-3	88.3	1.48 \pm 0.18	0.93 \pm 0.19	1.21 \pm 0.19	18.4 \pm 1.1	15.5 \pm 1.0	13.5 \pm 1.0
22-S-525	35L	0+35	D-4	91.8	1.42 \pm 0.27	1.73 \pm 0.31	1.72 \pm 0.26	24.4 \pm 1.3	18.1 \pm 1.8	21.5 \pm 1.3
22-S-534	45L	0+35	D-5	90.5	1.69 \pm 0.25	1.47 \pm 0.31	1.34 \pm 0.25	24.5 \pm 1.6	22.7 \pm 2.0	26.4 \pm 1.6
22-S-547	55L	0+35	D-6	89.7	1.36 \pm 0.21	0.96 \pm 0.28	1.26 \pm 0.24	15.5 \pm 1.3	19.1 \pm 1.7	17.8 \pm 1.3
22-S-486	65L	0+35	D-7	93.8	1.59 \pm 0.25	1.62 \pm 0.26	1.40 \pm 0.27	36.7 \pm 1.6	35.6 \pm 1.6	27.6 \pm 1.6
22-S-499	75L	0+35	D-8	85.2	1.24 \pm 0.23	1.16 \pm 0.23	1.49 \pm 0.24	17.4 \pm 1.3	21.1 \pm 1.3	16.4 \pm 1.3
*22-S-541	85L	0+35	D-9	89.6	0.84 \pm 0.22	0.86 \pm 0.34	0.92 \pm 0.05	25.6 \pm 1.5	20.0 \pm 1.9	16.6 \pm 0.4
22-S-471	95L	0+35	D-10	90.3	1.51 \pm 0.22	0.63 \pm 0.22	1.31 \pm 0.22	23.5 \pm 1.5	22.8 \pm 1.4	24.1 \pm 1.4
22-S-389	105L	0+35	D-11	91.5	1.34 \pm 0.30	1.42 \pm 0.26	2.10 \pm 0.25	46.9 \pm 2.5	32.5 \pm 1.7	30.2 \pm 1.6
22-S-396	115L	0+35	D-12	87.8	1.63 \pm 0.26	1.05 \pm 0.21	1.50 \pm 0.24	38.6 \pm 2.0	25.0 \pm 1.4	25.6 \pm 1.4
22-S-382	125L	0+35	D-13	85.2	1.12 \pm 0.29	0.89 \pm 0.19	0.93 \pm 0.22	28.9 \pm 1.9	29.9 \pm 1.3	20.0 \pm 1.5
22-S-375	135L	0+35	D-14	88.2	1.88 \pm 0.32	1.17 \pm 0.24	1.36 \pm 0.29	42.5 \pm 2.3	29.2 \pm 1.6	27.6 \pm 1.7
22-S-367	145L	0+35	D-15	86.0	1.82 \pm 0.27	0.87 \pm 0.20	1.07 \pm 0.24	31.4 \pm 1.8	22.1 \pm 1.2	23.7 \pm 1.3
22-S-867	155L	0+35	KD-1	89.8	1.24 \pm 0.31	1.46 \pm 0.22	1.07 \pm 0.26	19.6 \pm 1.8	15.9 \pm 1.2	17.9 \pm 1.4
22-S-919	165L	0+35	KD-2	65.0	0.52 \pm 0.31	1.04 \pm 0.24	0.99 \pm 0.37	9.1 \pm 2.0	10.0 \pm 1.2	18.4 \pm 2.0
22-S-888	175L	0+35	KD-3	76.3	0.43 \pm 0.30	0.34 \pm 0.25	1.21 \pm 0.28	15.3 \pm 1.9	12.6 \pm 1.2	18.4 \pm 1.7
22-S-891	185L	0+35	KD-4	72.9	0.61 \pm 0.31	0.81 \pm 0.20	0.65 \pm 0.32	10.8 \pm 1.8	11.7 \pm 1.2	19.3 \pm 1.7

TABLE D.10 (Cont'd)

Sample No.	Coordinates X Y	Grid ID	Dry Wt %	Th-232 (911 keV)			K-40 (352 keV)			
				--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	
				pCi/g $\pm \sigma$	pCi/g $\pm \sigma$		pCi/g $\pm \sigma$	pCi/g $\pm \sigma$		
22-S-916	15R	0+45	AE-2	77.8	0.87±0.28	0.87±0.20	1.12±0.23	12.7±1.7	12.6±1.1	13.3±1.2
22-S-860	5R	0+45	AE-1	87.6	1.30±0.28	1.25±0.23	1.28±0.26	20.0±1.7	16.4±1.1	19.4±1.3
22-S-576	5L	0+45	E-1	NA	1.52±0.24	0.94±0.31	0.63±0.21	18.8±1.4	18.8±1.7	15.5±1.2
22-S-582	15L	0+45	E-2	NA	1.62±0.23	1.37±0.23	NA	26.8±1.5	18.1±1.3	NA
22-S-826	25L	0+45	E-3	84.9	1.16±0.21	1.08±0.23	1.63±0.26	30.4±1.4	21.1±1.3	22.3±1.4
22-S-524	35L	0+45	E-4	92.4	1.35±0.24	1.66±0.33	1.15±0.26	31.0±1.7	26.4±2.0	24.8±1.6
22-S-533	45L	0+45	E-5	91.3	0.97±0.21	0.77±0.27	0.91±0.23	24.0±1.5	21.0±1.8	23.2±1.4
22-S-548	55L	0+45	E-6	88.6	1.26±0.20	1.06±0.28	1.60±0.25	23.9±1.6	31.2±1.6	23.4±1.5
22-S-487	65L	0+45	E-7	93.3	1.70±0.25	1.43±0.24	1.60±0.25	25.3±1.6	20.9±1.3	25.2±1.4
22-S-498	75L	0+45	E-8	87.6	0.84±0.25	1.58±0.23	1.44±0.28	17.6±1.4	24.1±2.0	23.0±1.6
22-S-540	85L	0+45	E-9	89.8	1.86±0.25	1.40±0.33	1.45±0.24	26.3±1.6	25.1±1.4	19.6±1.4
22-S-469	95L	0+45	E-10	89.5	1.19±0.26	1.55±0.22	1.30±0.26	33.2±2.2	20.7±1.6	23.0±1.6
22-S-388	105L	0+45	E-11	90.8	1.59±0.31	1.22±0.26	1.10±0.25	33.2±2.2	31.2±1.7	25.1±1.6
22-S-395	115L	0+45	E-12	91.2	2.09±0.33	1.42±0.25	1.76±0.28	36.1±2.2	25.2±1.4	20.1±1.5
22-S-383	125L	0+45	E-13	86.9	2.46±0.30	1.08±0.25	1.07±0.25	36.1±2.2	31.2±1.7	25.1±1.6
22-S-376	135L	0+45	E-14	84.4	1.73±0.31	1.40±0.29	1.16±0.30	33.0±2.5	20.4±1.7	21.0±1.8
22-S-368	145L	0+45	E-15	81.6	1.50±0.22	1.05±0.19	1.14±0.26	24.5±1.7	15.1±1.0	18.7±1.3
22-S-868	155L	0+45	KE-1	85.8	1.26±0.29	1.32±0.22	1.59±0.26	29.3±1.7	19.4±1.2	20.9±1.4
22-S-920	165L	0+45	KE-2	69.1	0.96±0.34	0.78±0.27	1.33±0.39	13.9±2.1	14.2±1.3	21.0±1.9
22-S-873	175L	0+45	KE-3	76.7	NA	1.20±0.18	1.31±0.26	15.8±1.7	13.8±1.1	17.7±1.6
22-S-892	185L	0+45	KE-4	81.5	0.74±0.24	0.94±0.19	1.24±0.27	15.4±1.6	12.6±1.0	13.5±1.2
22-S-917	13R	0+55	AF-2	74.0	0.94±0.28	0.73±0.19	1.11±0.20	10.4±1.6	11.7±1.0	10.4±1.1
22-S-861	5R	0+55	AF-1	88.8	0.80±0.28	0.99±0.22	1.12±0.26	17.4±1.7	15.8±1.2	16.5±1.4
22-S-577	5L	0+55	F-1	NA	1.17±0.21	1.14±0.22	NA	18.4±1.3	14.1±1.1	NA
22-S-682	15L	0+55	F-2	91.5	1.45±0.23	1.27±0.32	1.48±0.23	18.4±1.3	19.9±1.9	20.6±1.4
22-S-787	25L	0+55	F-3	NA	1.63±0.20	1.43±0.28	NA	26.6±1.4	29.1±1.8	NA
22-S-523	35L	0+55	F-4	93.9	1.61±0.24	1.30±0.32	1.25±0.23	34.6±1.6	29.4±2.1	28.8±1.5
22-S-532	45L	0+55	F-5	91.1	1.21±0.24	1.11±0.33	1.14±0.31	24.5±1.6	26.5±2.1	21.1±1.5
22-S-549	55L	0+55	F-6	88.5	1.31±0.25	1.57±0.32	1.61±0.30	25.7±1.6	23.9±2.0	24.7±1.6
22-S-830	65L	0+55	F-7	83.4	1.07±0.15	1.26±0.15	1.72±0.22	16.2±1.0	14.0±0.8	20.2±1.2
22-S-681	75L	0+55	F-8	92.2	1.57±0.22	1.51±0.33	1.44±0.30	24.2±1.5	23.6±1.9	22.5±1.5
22-S-539	85L	0+55	F-9	88.4	1.17±0.22	1.41±0.33	1.08±0.27	21.7±1.6	22.2±2.0	22.7±1.7
22-S-683	95L	0+55	F-10	92.1	1.44±0.22	1.55±0.26	1.28±0.22	21.8±1.3	17.5±1.8	15.4±1.2
SS-2-472	105L	0+55	F-11	85.7	0.74±0.20	0.97±0.20	1.11±0.25	25.5±1.9	18.5±1.3	17.0±1.4
22-S-394	115L	0+55	F-12	89.0	1.36±0.30	1.44±0.23	1.46±0.24	15.5±1.9	18.1±1.4	18.1±1.4
22-S-384	125L	0+55	F-13	89.6	1.62±0.30	1.25±0.23	1.35±0.24	30.2±2.1	18.2±1.4	20.2±1.4

TABLE D.10 (Cont'd)

Sample No.	Coordinates		Grid ID	Dry Wt %	Th-232 (911 keV)			K-40 (352 keV)		
	X	Y			--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
					pCi/g \pm σ			pCi/g \pm σ		
22-S-377	135L	0+55	F-14	84.6	1.53 \pm 0.25	0.88 \pm 0.21	1.07 \pm 0.24	29.2 \pm 1.9	21.8 \pm 1.2	16.9 \pm 1.3
22-S-369	145L	0+55	F-15	80.0	1.20 \pm 0.20	0.86 \pm 0.17	0.81 \pm 0.24	20.4 \pm 1.4	14.1 \pm 1.0	18.0 \pm 1.2
22-S-921	155L	0+55	KF-1	86.2	1.28 \pm 0.32	1.20 \pm 0.17	1.55 \pm 0.25	13.9 \pm 1.7	13.7 \pm 1.1	16.0 \pm 1.4
22-S-895	165L	0+55	KF-2	78.7	1.27 \pm 0.26	1.26 \pm 0.20	1.33 \pm 0.29	35.9 \pm 1.6	13.4 \pm 1.1	18.4 \pm 1.5
*22-S-894	175L	0+55	KF-3	74.8	0.76 \pm 0.30	1.10 \pm 0.22	1.54 \pm 0.12	16.3 \pm 1.8	14.8 \pm 1.2	18.3 \pm 0.8
22-S-893	185L	0+55	KF-4	79.5	0.84 \pm 0.28	0.85 \pm 0.15	0.84 \pm 0.25	18.0 \pm 1.6	14.3 \pm 0.8	15.4 \pm 1.4
22-S-918	15R	0+65	AG-2	77.1	0.82 \pm 0.30	0.91 \pm 0.21	1.44 \pm 0.27	14.6 \pm 1.7	12.0 \pm 1.1	16.3 \pm 1.5
22-S-862	5R	0+65	AG-1	83.9	0.75 \pm 0.25	1.03 \pm 0.21	2.03 \pm 0.31	13.7 \pm 1.5	12.1 \pm 1.0	17.5 \pm 1.5
22-S-578	5L	0+65	G-1	NA	1.47 \pm 0.23	1.31 \pm 0.21	NA	17.6 \pm 1.3	13.9 \pm 1.1	NA
*22-S-584	15L	0+65	G-2	90.8	1.47 \pm 0.20	NA	1.34 \pm 0.03	23.6 \pm 1.3	NA	17.2 \pm 0.2
22-S-804	25L	0+65	G-3	89.5	1.35 \pm 0.21	1.58 \pm 0.19	1.13 \pm 0.20	29.9 \pm 1.3	19.6 \pm 1.2	19.2 \pm 1.1
22-S-522	35L	0+65	G-4	92.9	1.52 \pm 0.28	1.39 \pm 0.28	1.77 \pm 0.23	32.2 \pm 1.7	31.3 \pm 2.0	26.8 \pm 1.5
22-S-531	45L	0+65	G-5	90.1	1.25 \pm 0.23	0.95 \pm 0.32	1.22 \pm 0.27	26.9 \pm 1.5	22.5 \pm 1.9	25.2 \pm 1.5
22-S-550	55L	0+65	G-6	89.3	1.61 \pm 0.25	1.59 \pm 0.31	1.31 \pm 0.26	22.6 \pm 1.6	26.8 \pm 2.1	25.8 \pm 1.6
22-S-489	65L	0+65	G-7	92.3	1.75 \pm 0.24	1.51 \pm 0.23	1.79 \pm 0.23	29.6 \pm 1.5	25.4 \pm 1.5	17.7 \pm 1.3
*22-S-476	75L	0+65	G-8	87.7	0.81 \pm 0.22	1.07 \pm 0.22	1.22 \pm 0.03	17.5 \pm 1.4	13.0 \pm 1.4	13.7 \pm 0.2
22-S-496	75L	0+65	G-8	87.2	0.82 \pm 0.22	1.32 \pm 0.23	1.59 \pm 0.23	14.7 \pm 1.3	16.8 \pm 1.3	13.4 \pm 1.2
22-S-478	85L	0+65	G-9	87.1	1.26 \pm 0.19	1.43 \pm 0.24	1.38 \pm 0.26	20.7 \pm 1.5	25.3 \pm 1.3	16.5 \pm 1.4
22-S-473	95L	0+65	G-10	89.3	1.05 \pm 0.21	0.83 \pm 0.21	0.99 \pm 0.25	20.6 \pm 1.4	23.1 \pm 1.5	20.4 \pm 1.3
22-S-474	105L	0+65	G-11	78.4	1.33 \pm 0.20	1.05 \pm 0.22	1.01 \pm 0.16	21.8 \pm 1.3	21.5 \pm 1.3	15.6 \pm 0.9
22-S-833	115L	0+65	G-12	85.3	1.22 \pm 0.17	0.92 \pm 0.15	1.42 \pm 0.22	16.8 \pm 1.1	14.0 \pm 0.9	17.3 \pm 1.3
22-S-385	125L	0+65	G-13	88.2	1.24 \pm 0.27	1.03 \pm 0.25	1.59 \pm 0.26	32.7 \pm 2.1	20.7 \pm 1.4	20.5 \pm 1.4
22-S-774	135L	0+65	G-14	91.1	1.67 \pm 0.22	0.61 \pm 0.31	1.44 \pm 0.28	23.4 \pm 1.4	22.4 \pm 1.9	23.7 \pm 1.5
*22-S-378	135L	0+65	G-14	83.0	1.39 \pm 0.29	1.71 \pm 0.24	1.05 \pm 0.04	24.1 \pm 2.0	24.6 \pm 1.4	19.5 \pm 0.3
*22-S-370	145L	0+65	G-15	77.9	1.06 \pm 0.24	1.16 \pm 0.20	1.03 \pm 0.05	20.5 \pm 1.6	13.8 \pm 1.1	17.2 \pm 0.4
22-S-769	145L	0+65	G-15	87.8	1.19 \pm 0.23	1.02 \pm 0.32	1.56 \pm 0.28	20.2 \pm 1.5	18.3 \pm 2.0	17.6 \pm 1.4
*22-S-875	155L	0+65	KG-1	86.4	1.14 \pm 0.33	0.74 \pm 0.23	1.55 \pm 0.16	15.1 \pm 1.9	16.9 \pm 1.3	21.3 \pm 0.9
22-S-896	165L	0+65	KG-2	79.7	1.06 \pm 0.28	0.93 \pm 0.21	1.20 \pm 0.28	27.4 \pm 1.8	16.9 \pm 1.2	22.5 \pm 1.5
*22-S-863	5R	0+75	AH-1	76.7	0.94 \pm 0.28	0.77 \pm 0.21	1.45 \pm 0.15	13.2 \pm 1.7	10.8 \pm 1.1	15.5 \pm 0.8
22-S-579	5L	0+75	H-1	NA	0.91 \pm 0.21	0.64 \pm 0.18	NA	14.3 \pm 1.1	12.3 \pm 1.0	NA
22-S-724	15L	0+75	H-2	82.9	0.91 \pm 0.18	1.06 \pm 0.25	0.85 \pm 0.16	16.1 \pm 1.2	14.5 \pm 1.4	15.0 \pm 1.0
22-S-810	25L	0+75	H-3	85.3	1.52 \pm 0.22	0.86 \pm 0.19	1.62 \pm 0.26	26.1 \pm 1.3	18.5 \pm 1.2	24.0 \pm 1.4
22-S-521	35L	0+75	H-4	93.0	1.50 \pm 0.25	1.03 \pm 0.34	1.02 \pm 0.25	30.5 \pm 1.7	30.1 \pm 2.0	27.3 \pm 1.6
22-S-530	45L	0+75	H-5	92.4	1.08 \pm 0.21	BDL	NA	30.1 \pm 1.5	24.3 \pm 1.9	NA
22-S-551	55L	0+75	H-6	91.5	1.12 \pm 0.23	0.98 \pm 0.30	1.03 \pm 0.26	25.8 \pm 1.6	35.7 \pm 1.9	23.8 \pm 1.5

TABLE D.10 (Cont'd)

Sample No.	Coordinates X Y	Grid ID	Dry Wt %	Th-232 (911 keV)			K-40 (352 keV)		
				--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
				pCi/g $\pm \sigma$			pCi/g $\pm \sigma$		
22-S-490	65L 0+75	H-7	93.0	1.70 \pm 0.22	1.23 \pm 0.23	1.76 \pm 0.24	30.5 \pm 1.5	27.6 \pm 1.5	17.2 \pm 1.4
*22-S-495	75L 0+75	H-8	88.0	1.03 \pm 0.25	1.44 \pm 0.22	1.21 \pm 0.03	18.4 \pm 1.5	17.8 \pm 1.5	15.9 \pm 0.2
22-S-477	85L 0+75	H-9	89.7	0.93 \pm 0.22	1.38 \pm 0.21	1.33 \pm 0.26	18.8 \pm 1.2	13.9 \pm 1.3	14.2 \pm 1.4
22-S-468	95L 0+75	H-10	90.0	1.44 \pm 0.24	1.63 \pm 0.24	1.03 \pm 0.26	29.3 \pm 1.6	32.8 \pm 1.6	29.0 \pm 1.6
22-S-466	105L 0+75	H-11	88.5	1.09 \pm 0.20	1.03 \pm 0.20	1.64 \pm 0.23	21.0 \pm 1.5	19.3 \pm 1.3	19.6 \pm 1.4
22-S-748	115L 0+75	H-12	82.9	0.98 \pm 0.16	1.03 \pm 0.23	0.76 \pm 0.17	17.3 \pm 1.1	15.6 \pm 1.3	13.8 \pm 0.9
22-S-716	125L 0+75	H-13	90.5	1.66 \pm 0.20	1.22 \pm 0.28	1.42 \pm 0.19	19.7 \pm 1.3	26.3 \pm 1.6	16.1 \pm 1.1
*22-S-694	135L 0+75	H-14	87.5	1.35 \pm 0.23	1.42 \pm 0.31	1.36 \pm 0.05	17.7 \pm 1.4	15.0 \pm 1.9	19.2 \pm 0.4
22-S-371	145L 0+75	H-15	77.9	1.28 \pm 0.22	0.72 \pm 0.17	1.02 \pm 0.22	24.4 \pm 1.5	15.2 \pm 1.1	17.4 \pm 1.2
22-S-876	155L 0+75	KH-1	78.3	1.36 \pm 0.35	0.87 \pm 0.21	1.08 \pm 0.30	21.1 \pm 2.0	15.3 \pm 1.4	22.3 \pm 1.7
22-S-897	165L 0+75	KH-2	73.6	1.87 \pm 0.25	1.52 \pm 0.21	1.24 \pm 0.19	26.2 \pm 1.5	17.3 \pm 1.1	18.7 \pm 1.2
22-S-905	5R 0+85	AJ-1	61.9	0.44 \pm 0.29	0.87 \pm 0.23	1.15 \pm 0.39	8.3 \pm 1.9	9.4 \pm 1.1	14.8 \pm 1.9
22-S-854	5L 0+85	J-1	84.2	1.42 \pm 0.27	0.81 \pm 0.20	1.25 \pm 0.24	16.8 \pm 1.6	13.9 \pm 1.0	17.3 \pm 1.4
22-S-819	15L 0+85	J-2	83.3	1.26 \pm 0.18	1.00 \pm 0.19	1.13 \pm 0.21	15.8 \pm 1.1	13.3 \pm 0.9	17.3 \pm 1.2
22-S-811	25L 0+85	J-3	85.7	1.42 \pm 0.21	0.95 \pm 0.20	1.65 \pm 0.26	21.9 \pm 1.2	13.4 \pm 1.1	17.6 \pm 1.3
22-S-821	35L 0+85	J-4	94.2	1.45 \pm 0.18	1.72 \pm 0.23	1.37 \pm 0.25	33.6 \pm 1.5	25.8 \pm 1.4	27.0 \pm 1.5
22-S-529	45L 0+85	J-5	93.8	1.71 \pm 0.24	1.11 \pm 0.31	NA	34.5 \pm 1.6	28.1 \pm 2.0	NA
22-S-552	55L 0+85	J-6	91.5	1.21 \pm 0.23	1.41 \pm 0.31	1.17 \pm 0.26	21.2 \pm 1.4	28.7 \pm 1.8	18.8 \pm 1.3
22-S-491	65L 0+85	J-7	91.4	1.43 \pm 0.22	1.15 \pm 0.25	0.97 \pm 0.22	24.9 \pm 1.5	21.6 \pm 1.5	16.2 \pm 1.2
22-S-493	75L 0+85	J-8	87.5	1.27 \pm 0.22	1.23 \pm 0.24	0.71 \pm 0.22	21.6 \pm 1.3	15.0 \pm 1.3	12.6 \pm 1.1
22-S-479	85L 0+85	J-9	88.6	1.37 \pm 0.21	1.46 \pm 0.22	1.69 \pm 0.24	22.1 \pm 1.3	23.4 \pm 1.3	16.4 \pm 1.4
22-S-465	95L 0+85	J-10	90.1	1.33 \pm 0.23	1.09 \pm 0.21	1.44 \pm 0.24	25.5 \pm 1.5	25.5 \pm 1.5	23.0 \pm 1.4
22-S-467	105L 0+85	J-11	79.0	1.38 \pm 0.21	1.28 \pm 0.20	1.90 \pm 0.26	19.1 \pm 0.1	21.2 \pm 1.2	17.5 \pm 1.2
22-S-747	115L 0+85	J-12	84.2	1.08 \pm 0.17	1.03 \pm 0.24	0.97 \pm 0.16	15.7 \pm 1.1	13.9 \pm 1.3	13.5 \pm 0.8
22-S-717	125L 0+85	J-13	93.5	1.08 \pm 0.22	1.22 \pm 0.32	1.38 \pm 0.22	26.6 \pm 1.6	35.9 \pm 1.9	25.2 \pm 1.4
22-S-693	135L 0+85	J-14	91.3	1.33 \pm 0.22	1.12 \pm 0.29	1.18 \pm 0.24	24.9 \pm 1.4	22.7 \pm 1.8	21.2 \pm 1.3
22-S-690	145L 0+85	J-15	87.4	1.14 \pm 0.22	0.90 \pm 0.30	1.25 \pm 0.26	18.9 \pm 1.4	17.1 \pm 1.9	18.3 \pm 1.4
22-S-877	155L 0+85	KJ-1	83.1	0.65 \pm 0.30	0.84 \pm 0.16	1.74 \pm 0.26	20.9 \pm 1.9	16.1 \pm 0.9	24.3 \pm 1.6
22-S-898	165L 0+85	KJ-2	79.4	0.69 \pm 0.30	0.86 \pm 0.23	1.40 \pm 0.27	23.5 \pm 1.7	15.1 \pm 1.2	19.1 \pm 1.5
*22-S-906	5R 0+95	AK-1	75.9	0.51 \pm 0.32	0.94 \pm 0.22	1.54 \pm 0.18	13.0 \pm 1.8	10.7 \pm 1.1	13.9 \pm 1.1
*22-S-822	5L 0+95	K-1	74.5	1.13 \pm 0.21	0.76 \pm 0.21	1.34 \pm 0.07	15.9 \pm 1.2	10.5 \pm 1.1	15.0 \pm 0.4
22-S-800	15L 0+95	K-2	81.6	1.09 \pm 0.21	1.01 \pm 0.20	0.52 \pm 0.20	18.7 \pm 1.1	13.0 \pm 1.0	12.7 \pm 1.0
22-S-802	25L 0+95	K-3	85.0	1.51 \pm 0.18	0.70 \pm 0.19	1.31 \pm 0.19	20.6 \pm 1.1	16.2 \pm 1.0	14.4 \pm 1.0
22-S-801	35L 0+95	K-4	92.1	1.33 \pm 0.22	1.24 \pm 0.23	1.76 \pm 0.22	34.1 \pm 1.5	27.2 \pm 1.4	27.7 \pm 1.4
22-S-528	45L 0+95	K-5	91.6	1.30 \pm 0.21	1.21 \pm 0.28	0.86 \pm 0.26	24.7 \pm 1.3	19.2 \pm 1.8	15.9 \pm 1.3

TABLE D.10 (Cont'd)

Sample No.	Coordinates X Y	Grid ID	Dry Wt %	Th-232 (911 keV) pCi/g \pm σ			K-40 (352 keV) pCi/g \pm σ			
				--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	
22-S-553	55L	0+95	K-6	88.7	1.04 \pm 0.23	1.31 \pm 0.30	0.85 \pm 0.27	18.9 \pm 1.4	16.3 \pm 1.7	17.3 \pm 1.3
22-S-492	65L	0+95	K-7	88.9	1.47 \pm 0.27	1.07 \pm 0.24	1.25 \pm 0.23	24.3 \pm 1.3	20.5 \pm 1.5	14.0 \pm 1.2
22-S-834	75L	0+95	K-8	81.7	0.85 \pm 0.17	1.00 \pm 0.16	1.16 \pm 0.23	15.0 \pm 1.1	12.1 \pm 0.9	17.1 \pm 1.2
*22-S-480	85L	0+95	K-9	88.6	1.26 \pm 0.23	1.15 \pm 0.22	1.22 \pm 0.06	24.5 \pm 1.3	22.6 \pm 1.4	16.6 \pm 0.5
22-S-464	95L	0+95	K-10	87.2	1.55 \pm 0.20	1.56 \pm 0.22	1.65 \pm 0.24	22.2 \pm 1.3	21.0 \pm 1.4	20.7 \pm 1.3
22-S-463	105L	0+95	K-11	85.3	1.73 \pm 0.21	1.36 \pm 0.22	1.69 \pm 0.22	19.0 \pm 1.3	20.9 \pm 1.3	20.5 \pm 1.3
22-S-838	115L	0+95	K-12	83.2	1.45 \pm 0.21	1.10 \pm 0.19	1.44 \pm 0.23	26.1 \pm 1.3	17.7 \pm 1.1	21.5 \pm 1.4
22-S-718	125L	0+95	K-13	93.8	1.58 \pm 0.20	1.27 \pm 0.28	1.36 \pm 0.22	31.0 \pm 1.5	26.8 \pm 1.8	24.6 \pm 1.3
22-S-692	135L	0+95	K-14	87.1	1.28 \pm 0.21	1.06 \pm 0.28	0.84 \pm 0.24	19.5 \pm 1.3	19.2 \pm 1.7	18.5 \pm 1.3
22-S-695	145L	0+95	K-15	87.0	1.13 \pm 0.19	0.68 \pm 0.26	0.89 \pm 0.22	14.8 \pm 1.2	20.0 \pm 1.7	23.7 \pm 1.3
22-S-878	155L	0+95	KK-1	81.5	1.25 \pm 0.30	1.58 \pm 0.20	1.53 \pm 0.28	14.2 \pm 1.8	15.2 \pm 1.2	18.5 \pm 1.6
22-S-899	165L	0+95	KK-2	78.3	BDL	0.80 \pm 0.20	0.94 \pm 0.24	15.8 \pm 1.9	14.0 \pm 1.2	14.0 \pm 1.2
*22-S-907	5R	1+05	AL-1	76.3	0.64 \pm 0.30	0.69 \pm 0.23	1.44 \pm 0.17	14.6 \pm 1.8	10.7 \pm 1.2	18.7 \pm 1.0
22-S-792	5L	1+05	L-1	82.5	1.01 \pm 0.20	0.63 \pm 0.23	1.33 \pm 0.19	15.4 \pm 1.1	12.1 \pm 1.4	9.8 \pm 1.0
*22-S-805	15L	1+05	L-2	81.5	0.88 \pm 0.23	0.74 \pm 0.21	0.95 \pm 0.04	17.1 \pm 1.0	11.9 \pm 1.0	14.7 \pm 0.3
22-S-807	25L	1+05	L-3	81.8	0.66 \pm 0.20	0.68 \pm 0.20	0.86 \pm 0.25	18.7 \pm 1.1	12.1 \pm 1.0	12.9 \pm 1.1
22-S-797	35L	1+05	L-4	88.6	1.24 \pm 0.19	1.02 \pm 0.19	1.46 \pm 0.19	26.2 \pm 1.3	21.7 \pm 1.2	21.1 \pm 1.2
22-S-701	45L	1+05	L-5	91.4	1.35 \pm 0.23	2.16 \pm 0.28	1.24 \pm 0.21	19.6 \pm 1.3	17.4 \pm 1.8	16.2 \pm 1.1
22-S-706	55L	1+05	L-6	88.1	1.03 \pm 0.20	0.98 \pm 0.28	1.12 \pm 0.20	16.1 \pm 1.2	14.4 \pm 0.2	13.3 \pm 1.0
22-S-823	65L	1+05	L-7	82.1	1.28 \pm 0.17	0.99 \pm 0.15	1.20 \pm 0.21	17.6 \pm 1.0	12.8 \pm 0.9	16.6 \pm 1.1
22-S-739	75L	1+05	L-8	85.2	1.23 \pm 0.16	0.71 \pm 0.22	0.88 \pm 0.17	15.8 \pm 1.1	15.2 \pm 1.4	12.4 \pm 0.9
22-S-768	85L	1+05	L-9	87.4	1.10 \pm 0.22	0.98 \pm 0.26	1.34 \pm 0.24	18.3 \pm 1.2	17.0 \pm 1.5	18.1 \pm 1.2
22-S-827	95L	1+05	L-10	83.1	1.09 \pm 0.16	0.75 \pm 0.16	1.03 \pm 0.23	18.0 \pm 0.9	12.4 \pm 0.9	15.3 \pm 1.1
22-S-829	105L	1+05	L-11	85.2	1.36 \pm 0.17	0.91 \pm 0.15	0.94 \pm 0.19	13.6 \pm 0.9	12.5 \pm 0.8	15.0 \pm 1.1
22-S-757	115L	1+05	L-12	83.5	1.00 \pm 0.15	1.22 \pm 0.19	0.86 \pm 0.15	16.4 \pm 0.9	15.2 \pm 1.2	12.2 \pm 0.8
22-S-719	125L	1+05	L-13	89.5	1.39 \pm 0.19	1.18 \pm 0.27	1.24 \pm 0.20	27.0 \pm 1.4	31.5 \pm 1.6	21.4 \pm 1.2
22-S-685	135L	1+05	L-14	84.5	1.25 \pm 0.21	1.17 \pm 0.30	1.38 \pm 0.26	19.1 \pm 0.1	16.2 \pm 1.6	15.7 \pm 1.3
22-S-696	145L	1+05	L-15	83.8	1.05 \pm 0.21	0.79 \pm 0.27	1.67 \pm 0.23	18.6 \pm 1.3	16.0 \pm 1.7	16.7 \pm 1.4
22-S-879	155L	1+05	KL-1	87.1	0.86 \pm 0.29	0.94 \pm 0.22	1.60 \pm 0.07	16.1 \pm 1.8	13.7 \pm 1.2	18.0 \pm 0.4
*22-S-922	165L	1+05	KL-2	78.9	0.73 \pm 0.33	1.31 \pm 0.24	1.71 \pm 0.12	17.7 \pm 2.0	16.8 \pm 1.4	21.5 \pm 0.7
*22-S-908	5R	1+15	AM-1	75.9	1.09 \pm 0.33	0.85 \pm 0.21	1.81 \pm 0.18	14.1 \pm 1.8	11.4 \pm 1.2	17.8 \pm 1.0
22-S-781	5L	1+15	M-1	NA	0.80 \pm 0.22	0.47 \pm 0.30	NA	9.2 \pm 1.2	11.2 \pm 1.7	NA
*22-S-679	15L	1+15	M-2	83.1	1.23 \pm 0.20	0.91 \pm 0.28	1.04 \pm 0.02	14.3 \pm 1.3	14.5 \pm 1.7	14.0 \pm 0.1
22-S-783	15L	1+15	M-2	NA	0.97 \pm 0.22	0.51 \pm 0.32	NA	12.5 \pm 1.3	12.2 \pm 1.9	NA
22-S-798	25L	1+15	M-3	86.1	1.07 \pm 0.18	1.25 \pm 0.18	1.15 \pm 0.20	29.1 \pm 1.3	20.8 \pm 1.1	21.7 \pm 1.1

TABLE D.10 (Cont'd)

Sample No.	Coordinates		Grid ID	Dry Wt %	Th-232 (911 keV)		K-40 (352 keV)	
					--Initial--	--Aged-- pCi/g \pm σ	--Initial--	--Aged-- pCi/g \pm σ
	X	Y			--Dried--		--Dried--	
*22-S-796	35L	1+15	M-4	82.6	0.82 \pm 0.22	1.06 \pm 0.20	15.2 \pm 1.1	12.1 \pm 1.0
22-S-702	45L	1+15	M-5	90.8	1.52 \pm 0.24	1.22 \pm 0.29	24.9 \pm 1.5	24.3 \pm 1.8
22-S-707	55L	1+15	M-6	91.1	1.27 \pm 0.23	1.41 \pm 0.28	19.1 \pm 1.3	16.4 \pm 1.7
22-S-712	65L	1+15	M-7	90.0	1.47 \pm 0.24	1.15 \pm 0.33	17.8 \pm 1.4	18.0 \pm 1.9
22-S-776	75L	1+15	M-8	89.2	1.46 \pm 0.21	0.49 \pm 0.30	18.7 \pm 1.3	18.1 \pm 1.8
22-S-825	85L	1+15	M-9	83.5	1.44 \pm 0.18	1.10 \pm 0.17	20.4 \pm 1.0	12.4 \pm 0.9
22-S-737	95L	1+15	M-10	81.4	1.12 \pm 0.17	0.78 \pm 0.26	15.5 \pm 1.1	14.6 \pm 1.5
22-S-731	105L	1+15	M-11	82.6	1.19 \pm 0.14	1.00 \pm 0.21	15.7 \pm 0.9	13.0 \pm 1.2
22-S-766	115L	1+15	M-12	81.5	1.12 \pm 0.17	0.51 \pm 0.21	16.8 \pm 1.0	15.2 \pm 1.3
22-S-720	125L	1+15	M-13	91.5	1.69 \pm 0.22	1.26 \pm 0.27	22.6 \pm 1.3	27.4 \pm 1.6
22-S-686	135L	1+15	M-14	85.6	1.22 \pm 0.22	1.36 \pm 0.35	23.7 \pm 1.4	17.0 \pm 1.9
22-S-697	145L	1+15	M-15	79.3	1.03 \pm 0.21	1.30 \pm 0.26	15.7 \pm 1.2	15.0 \pm 1.6
22-S-880	155L	1+15	KM-1	82.7	1.04 \pm 0.27	0.83 \pm 0.20	11.6 \pm 1.6	12.3 \pm 1.1
22-S-901	165L	1+15	KM-2	78.2	BDL	0.81 \pm 0.23	19.7 \pm 1.9	13.2 \pm 1.2
22-S-909	5R	1+25	AN-1	78.3	0.92 \pm 0.26	1.19 \pm 0.18	12.8 \pm 1.7	10.7 \pm 1.0
22-S-782	5L	1+25	N-1	NA	0.99 \pm 0.19	1.09 \pm 0.29	19.3 \pm 1.1	13.7 \pm 1.5
22-S-832	15L	1+25	N-2	85.1	1.21 \pm 0.17	1.00 \pm 0.17	15.8 \pm 1.1	15.3 \pm 1.0
22-S-786	25L	1+25	N-3	NA	1.06 \pm 0.23	1.11 \pm 0.27	13.6 \pm 1.2	14.8 \pm 1.7
22-S-814	35L	1+25	N-4	82.4	1.29 \pm 0.15	0.90 \pm 0.15	21.1 \pm 1.0	16.2 \pm 0.9
22-S-703	45L	1+25	N-5	90.0	1.63 \pm 0.20	1.02 \pm 0.28	22.6 \pm 1.3	20.4 \pm 1.6
*22-S-708	55L	1+25	N-6	92.2	0.84 \pm 0.23	0.99 \pm 0.30	21.9 \pm 1.4	15.5 \pm 1.7
22-S-713	65L	1+25	N-7	92.2	1.45 \pm 0.23	1.24 \pm 0.28	21.7 \pm 1.4	20.0 \pm 1.8
22-S-759	75L	1+25	N-8	85.0	1.20 \pm 0.18	1.03 \pm 0.25	16.5 \pm 1.0	18.7 \pm 1.4
22-S-773	85L	1+25	N-9	88.0	1.46 \pm 0.20	1.68 \pm 0.27	17.3 \pm 1.1	15.1 \pm 1.5
22-S-745	95L	1+25	N-10	86.3	1.09 \pm 0.18	1.19 \pm 0.24	17.2 \pm 1.2	14.2 \pm 1.4
22-S-733	105L	1+25	N-11	83.2	0.96 \pm 0.16	1.76 \pm 0.22	17.2 \pm 1.0	21.5 \pm 1.3
22-S-775	115L	1+25	N-12	90.2	1.03 \pm 0.24	1.00 \pm 0.29	20.0 \pm 1.4	15.6 \pm 1.7
*22-S-721	125L	1+25	N-13	90.4	1.47 \pm 0.22	1.36 \pm 0.27	20.4 \pm 1.4	16.2 \pm 1.6
22-S-687	135L	1+25	N-14	82.5	1.22 \pm 0.21	1.07 \pm 0.27	22.6 \pm 1.3	15.9 \pm 1.7
22-S-691	145L	1+25	N-15	83.5	0.83 \pm 0.21	0.89 \pm 0.26	14.0 \pm 1.1	16.0 \pm 1.6
22-S-881	155L	1+25	KM-1	81.2	1.31 \pm 0.28	1.21 \pm 0.21	15.3 \pm 1.7	10.0 \pm 1.1
22-S-902	165L	1+25	KM-2	77.4	1.18 \pm 0.30	0.97 \pm 0.22	12.6 \pm 1.7	12.4 \pm 1.2
								17.0 \pm 1.5

TABLE D.10 (Cont'd)

Sample No.	Coordinates X Y	Grid ID	Dry Wt %	Th-232 (911 keV)			K-40 (352 keV)		
				--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
				pCi/g $\pm \sigma$	pCi/g $\pm \sigma$	pCi/g $\pm \sigma$	pCi/g $\pm \sigma$	pCi/g $\pm \sigma$	pCi/g $\pm \sigma$
22-S-910	5R 1+35	AP-1	78.5	0.67±0.29	0.78±0.22	1.53±0.25	13.8±1.7	10.7±1.1	15.2±1.4
22-S-808	5L 1+35	P-1	77.6	1.15±0.21	0.96±0.21	NA	20.2±1.3	10.5±1.1	NA
22-S-794	15L 1+35	P-2	85.8	1.26±0.20	1.15±0.20	0.69±0.21	19.5±1.1	12.8±1.1	13.3±1.1
22-S-809	25L 1+35	P-3	84.9	1.06±0.21	0.84±0.18	1.10±0.22	14.4±1.1	13.4±0.9	14.7±1.2
22-S-793	35L 1+35	P-4	81.5	1.20±0.15	0.96±0.15	0.98±0.15	19.6±1.0	13.6±0.8	14.1±0.8
22-S-704	45L 1+35	P-5	91.1	1.00±0.20	1.14±0.28	1.38±0.20	18.5±1.3	26.0±1.6	15.4±1.1
22-S-709	55L 1+35	P-6	92.7	1.06±0.22	1.40±0.28	1.31±0.20	23.4±1.3	23.6±1.8	21.6±1.2
22-S-714	65L 1+35	P-7	84.9	1.46±0.20	1.27±0.30	0.95±0.20	20.0±1.4	17.3±1.7	15.0±1.1
22-S-743	75L 1+35	P-8	83.3	1.19±0.20	1.02±0.25	1.28±0.20	15.3±1.1	14.0±1.4	13.0±1.0
22-S-760	85L 1+35	P-9	86.6	1.29±0.19	1.06±0.24	1.04±0.19	17.6±1.1	17.4±1.5	18.2±1.1
22-S-740	95L 1+35	P-10	83.5	1.03±0.17	1.03±0.23	0.82±0.19	15.9±1.1	16.9±1.3	12.2±0.9
22-S-828	105L 1+35	P-11	82.8	1.19±0.18	1.21±0.16	1.58±0.21	20.4±1.1	12.9±0.9	18.4±1.1
22-S-824	115L 1+35	P-12	81.2	1.39±0.20	0.95±0.19	1.11±0.23	20.2±1.2	14.0±1.0	19.2±1.3
22-S-722	125L 1+35	P-13	89.4	1.60±0.22	1.01±0.26	1.56±0.21	22.1±1.3	23.0±1.6	20.0±1.2
22-S-688	135L 1+35	P-14	87.9	1.16±0.23	1.20±0.32	1.49±0.24	26.7±1.3	15.4±1.8	21.2±1.4
22-S-698	145L 1+35	P-15	80.8	1.11±0.24	1.11±0.34	1.68±0.30	18.9±1.5	13.8±1.9	17.0±1.4
22-S-882	155L 1+35	KP-1	79.8	0.90±0.27	0.92±0.17	1.19±0.26	12.3±1.6	12.3±1.1	15.5±1.4
22-S-903	165L 1+35	KP-2	79.1	0.57±0.32	0.51±0.21	1.60±0.30	15.3±1.9	12.8±1.2	17.3±1.5
*22-S-911	5R 1+45	AR-1	78.2	0.70±0.27	0.63±0.18	1.26±0.08	9.9±1.6	8.9±1.1	14.9±0.4
22-S-816	5L 1+45	R-1	85.8	1.11±0.17	1.00±0.17	1.36±0.22	19.3±1.0	13.6±0.9	18.4±1.1
*22-S-790	15L 1+45	R-2	80.6	1.09±0.20	1.24±0.30	0.83±0.04	13.3±1.2	13.3±1.6	13.0±0.4
22-S-795	25L 1+45	R-3	87.2	1.56±0.17	0.92±0.18	1.01±0.19	16.3±1.1	12.9±0.9	12.7±1.0
22-S-799	35L 1+45	R-4	87.6	1.04±0.17	0.93±0.18	1.16±0.19	17.0±1.1	12.6±1.0	11.6±1.0
22-S-705	45L 1+45	R-5	90.8	1.00±0.19	0.97±0.26	0.98±0.18	19.7±1.3	15.9±1.6	14.9±1.0
22-S-710	55L 1+45	R-6	92.0	1.33±0.22	0.95±0.29	1.20±0.21	19.3±1.3	23.1±1.8	19.1±1.2
22-S-715	65L 1+45	R-7	92.7	0.98±0.18	0.97±0.28	1.00±0.18	20.4±1.1	26.8±1.6	13.8±1.1
22-S-744	75L 1+45	R-8	86.1	1.01±0.22	1.24±0.25	1.16±0.18	17.7±1.2	17.8±1.4	13.1±1.0
22-S-741	85L 1+45	R-9	84.5	1.38±0.17	1.09±0.22	1.12±0.17	16.5±1.2	19.7±1.4	15.0±1.0
22-S-732	95L 1+45	R-10	76.0	1.00±0.18	0.96±0.23	0.85±0.16	17.0±1.1	14.8±1.4	11.1±0.9
22-S-777	105L 1+45	R-11	84.4	1.37±0.21	0.85±0.28	1.51±0.23	24.4±1.3	19.4±1.6	17.7±1.4
22-S-831	115L 1+45	R-12	76.4	0.76±0.19	0.84±0.19	1.61±0.24	14.0±1.1	10.1±0.9	17.0±1.3
22-S-700	125L 1+45	R-13	88.4	1.53±0.20	0.89±0.25	1.39±0.22	19.0±1.2	18.8±1.5	16.9±1.2
22-S-689	135L 1+45	R-14	70.3	0.86±0.21	1.33±0.30	1.28±0.26	15.3±1.3	14.0±1.6	13.8±1.4
*22-S-699	145L 1+45	R-15	77.0	0.95±0.23	0.70±0.31	1.04±0.04	13.7±1.3	14.0±1.8	14.8±0.0
22-S-883	155L 1+45	KR-1	79.2	1.00±0.32	1.21±0.22	0.92±0.28	14.6±1.8	10.1±1.1	17.1±1.5
22-S-904	165L 1+45	KR-2	75.5	1.11±0.33	0.74±0.20	1.35±0.32	16.8±2.0	12.8±1.2	16.4±1.7
22-S-750	185L 1+45	R-19	80.6	1.23±0.10	1.69±0.23	0.81±0.15	14.5±1.0	1.4±1.3	13.7±0.9

TABLE D.10 (Cont'd)

Sample No.	Coordinates X Y	Grid ID	Dry Wt %	Th-232 (911 keV)		K-40 (352 keV)			
				pCi/g $\pm \sigma$		pCi/g $\pm \sigma$			
				--Initial--	--Aged--	--Initial--	--Aged--		
				--Dried--	--Dried--	--Dried--	--Dried--		
22-S-669	65R 1+55	AS-7	NA	1.72 \pm 0.26	1.22 \pm 0.35	NA	13.0 \pm 1.3	9.5 \pm 1.9	NA
22-S-672	15R 1+55	AS-2	NA	1.02 \pm 0.22	0.72 \pm 0.31	NA	10.1 \pm 1.2	12.4 \pm 1.6	NA
22-S-671	5R 1+55	AS-1	NA	1.24 \pm 0.22	0.89 \pm 0.30	NA	15.4 \pm 1.3	13.9 \pm 1.8	NA
22-S-846	65L 1+55	S-7	88.8	1.10 \pm 0.22	1.13 \pm 0.19	1.42 \pm 0.25	21.1 \pm 1.2	13.2 \pm 1.0	16.0 \pm 1.3
22-S-845	75L 1+55	S-8	85.4	1.39 \pm 0.20	0.94 \pm 0.18	1.47 \pm 0.26	20.4 \pm 1.2	13.7 \pm 1.1	15.9 \pm 1.3
22-S-844	85L 1+55	S-9	85.6	1.36 \pm 0.24	1.41 \pm 0.22	1.75 \pm 0.26	25.7 \pm 1.3	15.4 \pm 1.1	20.6 \pm 1.5
22-S-843	95L 1+55	S-10	84.0	1.56 \pm 0.19	1.31 \pm 0.17	1.22 \pm 0.25	31.7 \pm 1.3	23.5 \pm 1.2	29.8 \pm 1.4
22-S-842	105L 1+55	S-11	84.5	1.54 \pm 0.22	1.35 \pm 0.22	1.47 \pm 0.27	30.8 \pm 1.3	25.9 \pm 1.2	29.8 \pm 1.5
22-S-841	115L 1+55	S-12	85.8	1.27 \pm 0.19	0.92 \pm 0.20	1.13 \pm 0.24	32.7 \pm 1.4	21.5 \pm 1.1	27.5 \pm 1.4
*22-S-675	165L 1+55	KS-2	86.3	0.95 \pm 0.20	1.12 \pm 0.27	1.03 \pm 0.05	13.7 \pm 1.1	13.9 \pm 1.5	15.2 \pm 0.3
22-S-676	175L 1+55	KS-2	NA	1.12 \pm 0.21	1.13 \pm 0.25	NA	13.2 \pm 1.1	11.8 \pm 1.5	NA
22-S-677	185L 1+55	KS-4	NA	0.92 \pm 0.20	BDL	NA	12.7 \pm 1.3	12.8 \pm 1.6	NA
*22-S-839	65L 1+65	T-7	91.0	1.27 \pm 0.23	0.91 \pm 0.18	1.54 \pm 0.10	15.9 \pm 1.3	16.0 \pm 1.2	14.7 \pm 0.6
22-S-840	85L 1+65	T-9	89.0	1.07 \pm 0.20	1.22 \pm 0.19	1.62 \pm 0.23	19.8 \pm 1.3	15.7 \pm 1.1	19.6 \pm 1.4
Stratford Sewer Line									
*22-S-519	55L 1+75	U-6	91.7	1.28 \pm 0.21	1.35 \pm 0.28	1.13 \pm 0.03	17.7 \pm 1.3	16.8 \pm 1.6	17.6 \pm 0.2
22-S-554	65L 1+75	U-7	90.5	0.81 \pm 0.24	1.16 \pm 0.27	0.93 \pm 0.23	18.1 \pm 1.2	20.0 \pm 1.6	18.4 \pm 1.2
*22-S-557	75L 1+75	U-8	89.0	1.20 \pm 0.21	1.01 \pm 0.26	1.01 \pm 0.04	18.7 \pm 1.2	13.7 \pm 1.5	17.0 \pm 0.3
22-S-573	85L 1+75	U-9	NA	1.18 \pm 0.20	1.33 \pm 0.27	1.45 \pm 0.24	32.9 \pm 1.5	30.7 \pm 1.8	26.6 \pm 1.3
22-S-570	95L 1+75	U-10	NA	1.37 \pm 0.22	1.68 \pm 0.27	1.33 \pm 0.22	30.4 \pm 1.5	28.2 \pm 1.8	25.8 \pm 1.3
22-S-566	105L 1+75	U-11	90.0	1.31 \pm 0.20	1.59 \pm 0.25	1.24 \pm 0.22	34.0 \pm 1.4	30.4 \pm 1.8	30.2 \pm 1.5
22-S-571	115L 1+75	U-12	NA	1.43 \pm 0.23	1.21 \pm 0.30	1.09 \pm 0.22	30.1 \pm 1.5	25.7 \pm 1.8	25.8 \pm 1.3
22-S-572	125L 1+75	U-13	NA	0.82 \pm 0.18	1.26 \pm 0.26	0.75 \pm 0.23	13.8 \pm 1.1	13.1 \pm 1.5	11.5 \pm 1.0
*22-S-590	135L 1+75	U-14	84.3	1.35 \pm 0.18	NA	1.18 \pm 0.04	21.5 \pm 1.2	NA	20.8 \pm 0.4
22-S-591	145L 1+75	U-15	NA	0.99 \pm 0.16	0.80 \pm 0.16	NA	17.7 \pm 1.0	17.2 \pm 0.9	NA
22-S-592	155L 1+75	U-16	NA	1.10 \pm 0.25	1.08 \pm 0.20	NA	18.3 \pm 1.4	14.6 \pm 1.2	NA
22-S-593	165L 1+75	U-17	NA	1.49 \pm 0.27	1.46 \pm 0.24	NA	21.3 \pm 1.5	13.0 \pm 1.3	NA
22-S-594	175L 1+75	U-18	NA	0.96 \pm 0.17	0.74 \pm 0.19	NA	20.9 \pm 1.1	11.8 \pm 0.9	NA
22-S-595	185L 1+85	U-19	NA	1.26 \pm 0.19	0.77 \pm 0.17	NA	20.0 \pm 1.1	11.2 \pm 1.0	NA
22-S-604	195L 1+85	V-20	NA	0.86 \pm 0.20	1.14 \pm 0.18	NA	15.7 \pm 1.2	12.3 \pm 1.0	NA
22-S-605	205L 1+85	V-21	NA	0.97 \pm 0.19	1.16 \pm 0.19	NA	13.8 \pm 1.1	12.2 \pm 1.0	NA
22-S-606	215L 1+85	V-22	NA	1.42 \pm 0.18	0.88 \pm 0.18	NA	14.6 \pm 1.1	10.2 \pm 0.9	NA
22-S-607	225L 1+85	V-23	NA	0.94 \pm 0.21	0.95 \pm 0.18	NA	14.9 \pm 1.1	13.6 \pm 1.0	NA

TABLE D.10 (Cont'd)

Sample No.	Coordinates		Grid ID	Dry Wt %	Th-232 (911 keV)		K-40 (352 keV)	
	X	Y			--Initial--	--Aged-- pCi/g \pm σ	--Initial--	--Aged-- pCi/g \pm σ
22-S-608	235L	1+85	V-24	NA	0.74 \pm 0.19	0.65 \pm 0.19	18.2 \pm 1.2	10.9 \pm 1.0
22-S-613	245L	1+85	V-25	NA	1.22 \pm 0.19	1.33 \pm 0.19	22.3 \pm 1.2	14.6 \pm 1.1
*22-S-610	255L	1+85	V-26	90.6	1.28 \pm 0.18	NA	16.8 \pm 1.1	NA
22-S-614	265L	1+85	V-27	NA	0.89 \pm 0.20	1.03 \pm 0.20	21.2 \pm 1.1	14.2 \pm 1.0
22-S-615	275L	1+85	V-28	NA	0.87 \pm 0.19	1.00 \pm 0.18	17.2 \pm 1.3	13.8 \pm 1.1
22-S-616	285L	1+85	V-29	NA	0.79 \pm 0.19	0.96 \pm 0.19	20.6 \pm 1.4	16.9 \pm 1.2
South Parkway								
22-S-637	45L	1+85	V-5	NA	0.94 \pm 0.21	0.85 \pm 0.34	14.8 \pm 1.2	9.7 \pm 1.8
22-S-636	55L	1+85	V-6	NA	1.22 \pm 0.18	1.20 \pm 0.30	15.8 \pm 1.2	14.6 \pm 1.7
22-S-635	65L	1+85	V-7	NA	1.01 \pm 0.17	1.37 \pm 0.31	13.4 \pm 1.0	13.3 \pm 1.7
*22-S-634	75L	1+85	V-8	82.1	1.01 \pm 0.18	1.17 \pm 0.29	16.4 \pm 0.9	11.4 \pm 1.8
22-S-638	85L	1+85	V-9	NA	1.11 \pm 0.19	0.72 \pm 0.32	14.2 \pm 1.1	10.7 \pm 1.6
22-S-632	105L	1+85	V-11	NA	1.03 \pm 0.20	1.15 \pm 0.32	17.1 \pm 1.1	11.0 \pm 1.8
22-S-631	115L	1+85	V-12	NA	0.94 \pm 0.19	0.94 \pm 0.17	17.6 \pm 1.0	13.4 \pm 0.9
22-S-630	125L	1+85	V-13	NA	0.77 \pm 0.19	0.88 \pm 0.16	10.5 \pm 1.0	9.6 \pm 0.9
22-S-629	135L	1+85	V-14	NA	1.12 \pm 0.19	0.62 \pm 0.18	13.4 \pm 1.1	8.3 \pm 1.0
Ave				85.0	1.21	1.11	20.4	17.5
Std dev				5.5	0.32	0.29	6.6	5.6
Max				94.3	2.39	2.24	46.9	35.9
Min				61.9	0.43	0.46	8.3	8.3
No. of Samples				324	392	391	396	393

*Samples dried and analyzed by the Analytical Chemistry Laboratory (ACL).

σUncertainty in the counting statistics.

NA = data not available.

BDL = below detectable level.

TABLE D.11 Ra-226 Analyses of Backfill Soil

Sample No.	Dry Wt %	Ra-226 (186 keV)			Pb-214 (352 keV)			Bi-214 (609 keV)		
		--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
		pCi/g \pm σ			pCi/g \pm σ			pCi/g \pm σ		
22-SB-618	NA	BDL	BDL	NA	0.11 \pm 0.06	0.12 \pm 0.05	NA	BDL	BDL	NA
22-SB-619	NA	BDL	BDL	NA	0.11 \pm 0.06	0.14 \pm 0.05	NA	BDL	BDL	NA
22-SB-621	NA	BDL	BDL	NA	BDL	0.08 \pm 0.05	NA	0.15 \pm 0.06	0.10 \pm 0.06	NA
22-SB-623	NA	BDL	BDL	NA	0.11 \pm 0.06	0.14 \pm 0.05	NA	0.14 \pm 0.06	0.10 \pm 0.05	NA
22-SB-639	NA	BDL	1.12 \pm 0.45	NA	0.08 \pm 0.05	0.09 \pm 0.06	NA	0.15 \pm 0.06	BDL	NA
22-SB-847	89.8	BDL	BDL	BDL	0.12 \pm 0.05	BDL	0.14 \pm 0.06	0.09 \pm 0.05	0.09 \pm 0.05	0.14 \pm 0.06
22-SB-848	89.7	BDL	1.03 \pm 0.49	BDL	0.14 \pm 0.05	0.12 \pm 0.06	0.27 \pm 0.07	0.23 \pm 0.06	0.10 \pm 0.06	0.22 \pm 0.07
22-SB-849	89.6	BDL	BDL	BDL	0.13 \pm 0.07	0.19 \pm 0.07	0.30 \pm 0.08	BDL	0.17 \pm 0.07	0.21 \pm 0.09
*22-SB-851	92.0	BDL	BDL	NA	0.11 \pm 0.06	0.26 \pm 0.06	0.61 \pm 0.04	0.11 \pm 0.06	0.27 \pm 0.06	0.66 \pm 0.04
22-SB-923	92.2	BDL	BDL	BDL	BDL	0.17 \pm 0.06	0.10 \pm 0.06	0.15 \pm 0.06	0.12 \pm 0.06	BDL
22-SB-924	92.0	BDL	BDL	BDL	BDL	0.10 \pm 0.05	0.22 \pm 0.08	BDL	0.17 \pm 0.06	0.24 \pm 0.07
22-SB-925	89.7	BDL	0.90 \pm 0.45	BDL	BDL	0.14 \pm 0.06	0.27 \pm 0.06	0.14 \pm 0.10	0.16 \pm 0.06	0.36 \pm 0.07
Ave	90.7		1.02		0.12	0.14	0.27	0.15	0.14	0.31
Std dev	1.2		0.09		0.02	0.05	0.15	0.03	0.05	0.17
Max	92.2		1.12		0.15	0.26	0.61	0.23	0.27	0.66
Min	89.6		0.90		0.08	0.08	0.10	0.11	0.09	0.14
Number	7		3		8	11	7	8	9	6

*Samples Dried and Analyzed by ACL.
 σ Uncertainty in Counting Statistics.
 NA = Data Not Available.
 BDL = Below Detectable Level.

TABLE D.12 Th-232 and K-40 Analyses of Backfill Soil

Sample No.	Dry Wt %	Th-232 (911 keV)			K-40 (1460 keV)		
		--Initial--	--Aged--	--Dried--	--Initial--	--Aged--	--Dried--
		pCi/g $\pm \sigma$			pCi/g $\pm \sigma$		
22-SB-618	NA	0.26 \pm 0.14	0.27 \pm 0.10	NA	2.1 \pm 0.7	0.9 \pm 0.6	NA
22-SB-619	NA	0.42 \pm 0.12	BDL	NA	2.5 \pm 0.7	BDL	NA
22-SB-621	NA	0.31 \pm 0.12	BDL	NA	1.3 \pm 0.6	0.3 \pm 0.5	NA
22-SB-623	NA	BDL	BDL	NA	2.5 \pm 0.7	BDL	NA
22-SB-639	NA	BDL	0.23 \pm 0.09	NA	1.5 \pm 0.6	0.6 \pm 0.5	NA
22-SB-847	89.8	BDL	0.27 \pm 0.09	0.27 \pm 0.10	1.4 \pm 0.6	0.9 \pm 0.5	0.8 \pm 0.5
22-SB-848	89.7	0.35 \pm 0.12	0.36 \pm 0.12	0.26 \pm 0.11	2.2 \pm 0.7	1.5 \pm 0.5	1.6 \pm 0.7
22-SB-849	89.6	0.46 \pm 0.14	BDL	0.27 \pm 0.15	1.6 \pm 0.6	BDL	0.8 \pm 0.7
*22-SB-851	92.0	0.59 \pm 0.12	0.30 \pm 0.11	0.29 \pm 0.04	1.4 \pm 0.6	0.9 \pm 0.5	BDL
22-SB-923	92.2	BDL	0.15 \pm 0.09	0.34 \pm 0.12	BDL	BDL	1.3 \pm 0.6
22-SB-924	92.0	BDL	0.28 \pm 0.11	0.27 \pm 0.14	BDL	1.3 \pm 0.6	0.9 \pm 0.6
22-SB-925	89.7	BDL	0.33 \pm 0.09	0.53 \pm 0.11	BDL	BDL	BDL
Ave	90.7	0.27	0.32	1.8	0.9	1.1	
Std dev	1.2	0.06	0.09	0.5	0.4	0.3	
Max	92.2	0.36	0.53	2.5	1.5	1.6	
Min	89.6	0.15	0.26	1.3	0.3	0.8	
Number	7	8	7	9	7	5	

*Samples Dried and Analyzed by ACL.

 σ Uncertainty in Counting Statistics.

NA = Data Not Available.

BDL = Below Detectable Level.

APPENDIX E

APPENDIX E

TABULATED RESULTS OF FINAL VERIFICATION SOIL SAMPLE ANALYSES

Presented in this Appendix are the results of the final verification soil sample analyses for ^{226}Ra activity based on analysis of the 609 keV gamma ray of the ^{214}Bi daughter product. The sample preparation for analysis did not include soil drying but did include aging in a sealed Marinelli beaker for a minimum of 20 days. As noted at the bottom of the Table, the maximum ^{226}Ra activity concentration from analysis of 393 soil verification samples was 5.49 pCi/g, including the natural presence of ^{226}Ra in soil. All of the final verification soil samples are below the total ^{226}Ra activity concentration of 5 pCi/g above the natural background level of 1.5 pCi/g set as the clean-up criterion for this site.

Also shown in this Appendix are the results of 47 independent analyses performed by the ANL Analytical Chemistry Laboratory on final verification soil samples submitted for this purpose. The independent analyses conducted by ACL represent a re-analysis of approximately 12% of the final verification soil samples analyzed onsite at the ANL mobile laboratory. The purpose of these analyses was to ensure that the field measurements made on those samples near the clean-up criterion were valid. Therefore, the samples submitted to the ACL were biased in favor of those soil samples with ^{226}Ra concentrations near the clean-up criterion as determined from the field measurements. The ACL results are reported on a dry weight basis using the ^{214}Bi 609 keV gamma ray for quantifying the ^{226}Ra content of the soil samples.

Since the regulations/guidelines pertinent to measuring ^{226}Ra specify in "land," the results of the field analyses were used in determining whether or not the clean-up criterion has been met. Review of the field data in this Appendix shows that the soil clean-up criterion for the site has been achieved.

TABLE E.1 Results of Final Verification Soil Sample Analyses

Coordinates		Grid ID	Sample Date	Ra-226 (609 keV) pCi/g $\pm \sigma$	
X	Y			--- Field ---	--- ACL ---
5R	0-45	BE-1	04/27/89	1.60 \pm 0.15	
5L	0-45	CE-1	04/26/89	1.10 \pm 0.12	
15L	0-45	CE-2	04/26/89	0.96 \pm 0.23	
5R	0-35	BD-1	04/27/89	2.46 \pm 0.15	
5L	0-35	CD-1	04/26/89	4.05 \pm 0.22	3.77 \pm 0.05
15L	0-35	CD-2	04/26/89	0.86 \pm 0.22	
25L	0-35	CD-3	04/26/89	1.12 \pm 0.22	
35L	0-35	CD-4	04/26/89	1.15 \pm 0.23	
15R	0-25	BC-2	04/27/89	0.76 \pm 0.14	
5R	0-25	BC-1	04/27/89	1.99 \pm 0.14	
5L	0-25	CC-1	04/22/89	0.78 \pm 0.09	
15L	0-25	CC-2	04/22/89	0.53 \pm 0.10	
25L	0-25	CC-3	04/26/89	2.00 \pm 0.24	
35L	0-25	CC-4	04/26/89	1.93 \pm 0.25	
15R	0-15	BB-2	04/27/89	1.24 \pm 0.16	
5R	0-15	BB-1	04/27/89	1.20 \pm 0.17	
5L	0-15	CB-1	04/22/89	0.86 \pm 0.09	
15L	0-15	CB-2	04/22/89	1.19 \pm 0.11	
25L	0-15	CB-3	04/26/89	1.25 \pm 0.26	
35L	0-15	CB-4	04/26/89	2.13 \pm 0.25	2.71 \pm 0.04
45L	0-15	CB-5	05/02/89	0.94 \pm 0.11	
75L	0-15	CB-8	05/02/89	3.20 \pm 0.14	
85L	0-15	CB-9	05/02/89	1.88 \pm 0.13	
95L	0-15	CB-10	05/01/89	2.97 \pm 0.15	
105L	0-15	CB-11	05/02/89	2.90 \pm 0.14	
115L	0-15	CB-12	05/01/89	1.75 \pm 0.13	
125L	0-15	GB-1	05/01/89	1.90 \pm 0.14	
135L	0-15	GB-2	05/02/89	3.75 \pm 0.17	
145L	0-15	GB-3	05/02/89	3.44 \pm 0.15	3.49 \pm 0.11
155L	0-15	GB-4	05/01/89	2.48 \pm 0.15	
165L	0-15	GB-5	05/02/89	1.93 \pm 0.16	
175L	0-15	GB-6	05/02/89	1.52 \pm 0.14	
15R	0-05	BA-2	04/27/89	0.66 \pm 0.15	
5R	0-05	BA-1	04/27/89	1.75 \pm 0.15	
5L	0-05	CA-1	04/22/89	0.98 \pm 0.10	
15L	0-05	CA-2	04/22/89	1.37 \pm 0.12	
25L	0-05	CA-3	04/26/89	4.22 \pm 0.23	
35L	0-05	CA-4	04/26/89	2.37 \pm 0.26	
45L	0-05	CA-5	04/27/89	2.17 \pm 0.17	
55L	0-05	CA-6	04/27/89	2.59 \pm 0.18	
65L	0-05	CA-7	05/01/89	2.49 \pm 0.13	3.96 \pm 0.03

TABLE E.1 (Cont'd)

Coordinates		Grid ID	Sample Date	Ra-226 (609 keV) pCi/g $\pm \sigma$	
X	Y			--- Field ---	--- ACL ---
75L	0-05	CA-8	05/01/89	2.03 \pm 0.14	3.43 \pm 0.03
85L	0-05	CA-9	05/04/89	1.03 \pm 0.14	
95L	0-05	CA-10	05/04/89	2.55 \pm 0.16	4.07 \pm 0.02
105L	0-05	CA-11	05/01/89	2.68 \pm 0.15	
115L	0-05	CA-12	05/04/89	2.82 \pm 0.15	
125L	0-05	GA-1	05/04/89	1.50 \pm 0.10	
135L	0-05	GA-2	05/01/89	2.65 \pm 0.15	
145L	0-05	GA-3	05/01/89	2.53 \pm 0.14	4.70 \pm 0.02
155L	0-05	GA-4	05/01/89	1.55 \pm 0.14	
165L	0-05	GA-5	05/01/89	1.25 \pm 0.14	
175L	0-05	GA-6	01/28/89	1.82 \pm 0.13	
185L	0-05	GA-7	01/28/89	2.09 \pm 0.15	
195L	0-05	GA-8	05/01/89	4.73 \pm 0.19	
15R	0+05	AA-2	05/25/89	1.87 \pm 0.14	
5R	0+05	AA-1	05/20/89	1.99 \pm 0.13	
5L	0+05	A-1	05/04/89	3.10 \pm 0.15	
15L	0+05	A-2	05/04/89	2.64 \pm 0.14	
25L	0+05	A-3	05/04/89	1.62 \pm 0.14	3.57 \pm 0.03
35L	0+05	A-4	05/04/89	1.14 \pm 0.10	
45L	0+05	A-5	05/04/89	2.39 \pm 0.13	
55L	0+05	A-6	04/19/89	1.66 \pm 0.17	
65L	0+05	A-7	05/04/89	4.04 \pm 0.19	
75L	0+05	A-8	04/17/89	1.60 \pm 0.17	
85L	0+05	A-9	05/04/89	1.21 \pm 0.14	
95L	0+05	A-10	05/04/89	1.61 \pm 0.15	
105L	0+05	A-11	03/17/89	1.84 \pm 0.14	
115L	0+05	A-12	03/17/89	1.50 \pm 0.13	
125L	0+05	A-13	03/16/89	1.92 \pm 0.12	
135L	0+05	A-14	03/14/89	1.58 \pm 0.10	
145L	0+05	A-15	03/14/89	1.52 \pm 0.10	
155L	0+05	KA-1	05/20/89	1.01 \pm 0.11	
165L	0+05	KA-2	05/20/89	1.13 \pm 0.10	
175L	0+05	KA-3	05/20/89	2.29 \pm 0.13	
185L	0+05	KA-4	01/28/89	2.91 \pm 0.15	
195L	0+05	KA-5	01/28/89	1.97 \pm 0.14	
15R	0+15	AB-2	05/25/89	1.92 \pm 0.14	3.57 \pm 0.03
5R	0+15	AB-1	06/05/89	1.24 \pm 0.11	
5L	0+15	B-1	05/04/89	2.51 \pm 0.13	
15L	0+15	B-2	05/04/89	1.76 \pm 0.12	
25L	0+15	B-3	05/04/89	2.48 \pm 0.12	
35L	0+15	B-4	04/18/89	2.56 \pm 0.18	
45L	0+15	B-5	04/18/89	2.38 \pm 0.17	
55L	0+15	B-6	05/04/89	1.87 \pm 0.15	

TABLE E.1 (Cont'd)

Coordinates X Y		Grid ID	Sample Date	Ra-226 (609 keV) pCi/g $\pm \sigma$	
				--- Field ---	--- ACL ---
65L	0+15	B-7	05/04/89	3.63 \pm 0.21	5.65 \pm 0.07
75L	0+15	B-8	04/17/89	2.22 \pm 0.17	
85L	0+15	B-9	04/18/89	1.50 \pm 0.17	
95L	0+15	B-10	04/11/89	0.85 \pm 0.09	
105L	0+15	B-11	03/17/89	2.11 \pm 0.15	3.07 \pm 0.02
115L	0+15	B-12	03/17/89	1.95 \pm 0.12	
125L	0+15	B-13	03/16/89	2.00 \pm 0.13	
135L	0+15	B-14	03/14/89	1.08 \pm 0.10	
145L	0+15	B-15	03/14/89	1.13 \pm 0.09	
155L	0+15	KB-1	05/20/89	2.15 \pm 0.13	
165L	0+15	KB-2	05/20/89	3.60 \pm 0.16	
175L	0+15	KB-3	05/22/89	2.47 \pm 0.14	
185L	0+15	KB-4	05/22/89	2.75 \pm 0.15	
15R	0+25	AC-2	05/25/89	1.93 \pm 0.14	
5R	0+25	AC-1	05/20/89	5.49 \pm 0.20	5.75 \pm 0.11
5L	0+25	C-1	04/21/89	5.05 \pm 0.22	7.17 \pm 0.05
5L	0+25	C-1	06/05/89	2.41 \pm 0.14	
15L	0+25	C-2	04/21/89	3.02 \pm 0.16	
25L	0+25	C-3	05/04/89	2.00 \pm 0.11	
35L	0+25	C-4	04/18/89	1.78 \pm 0.18	
45L	0+25	C-5	04/18/89	2.04 \pm 0.18	
55L	0+25	C-6	04/19/89	1.42 \pm 0.17	
65L	0+25	C-7	04/18/89	0.71 \pm 0.17	
75L	0+25	C-8	04/17/89	0.99 \pm 0.18	
85L	0+25	C-9	04/18/89	0.89 \pm 0.16	
95L	0+25	C-10	05/04/89	1.13 \pm 0.16	
105L	0+25	C-11	03/17/89	1.90 \pm 0.14	
115L	0+25	C-12	03/17/89	1.75 \pm 0.12	
125L	0+25	C-13	03/16/89	1.48 \pm 0.11	
135L	0+25	C-14	03/14/89	1.66 \pm 0.12	
145L	0+25	C-15	03/14/89	1.25 \pm 0.10	
155L	0+25	KC-1	05/20/89	2.08 \pm 0.13	
165L	0+25	KC-2	05/20/89	3.21 \pm 0.16	4.33 \pm 0.09
175L	0+25	KC-3	05/22/89	1.67 \pm 0.13	
15R	0+35	AD-2	05/25/89	2.34 \pm 0.15	3.83 \pm 0.12
5R	0+35	AD-1	05/20/89	4.16 \pm 0.18	5.91 \pm 0.14
5L	0+35	D-1	04/21/89	2.26 \pm 0.17	
15L	0+35	D-2	04/22/89	1.81 \pm 0.12	
25L	0+35	D-3	05/04/89	1.91 \pm 0.12	
35L	0+35	D-4	04/18/89	2.14 \pm 0.17	
45L	0+35	D-5	04/18/89	0.76 \pm 0.17	
55L	0+35	D-6	04/19/89	1.10 \pm 0.16	
65L	0+35	D-7	04/14/89	1.84 \pm 0.14	

TABLE E.1 (Cont'd)

Coordinates		Grid ID	Sample Date	Ra-226 (609 keV) pCi/g $\pm \sigma$	
X	Y			--- Field ---	--- ACL ---
75L	0+35	D-8	04/17/89	1.93 \pm 0.13	3.03 \pm 0.05
85L	0+35	D-9	04/18/89	4.84 \pm 0.21	
95L	0+35	D-10	04/11/89	1.90 \pm 0.12	
105L	0+35	D-11	03/17/89	1.90 \pm 0.14	
115L	0+35	D-12	03/17/89	1.20 \pm 0.10	
125L	0+35	D-13	03/16/89	1.63 \pm 0.11	
135L	0+35	D-14	03/16/89	1.45 \pm 0.12	
145L	0+35	D-15	03/14/89	2.35 \pm 0.13	
155L	0+35	KD-1	05/20/89	1.78 \pm 0.14	
165L	0+35	KD-2	05/25/89	2.75 \pm 0.17	
175L	0+35	KD-3	05/22/89	2.56 \pm 0.16	
185L	0+35	KD-4	05/22/89	2.17 \pm 0.15	
15R	0+45	AE-2	05/25/89	2.20 \pm 0.14	
5R	0+45	AE-1	05/20/89	2.32 \pm 0.14	
5L	0+45	E-1	04/21/89	2.24 \pm 0.18	
15L	0+45	E-2	04/22/89	2.37 \pm 0.15	
25L	0+45	E-3	05/04/89	1.87 \pm 0.14	
35L	0+45	E-4	04/18/89	1.04 \pm 0.17	
45L	0+45	E-5	04/18/89	0.60 \pm 0.15	
55L	0+45	E-6	04/19/89	1.26 \pm 0.16	
65L	0+45	E-7	04/14/89	2.73 \pm 0.14	
75L	0+45	E-8	04/17/89	2.32 \pm 0.16	
85L	0+45	E-9	04/18/89	1.84 \pm 0.18	
95L	0+45	E-10	04/11/89	1.90 \pm 0.12	
105L	0+45	E-11	03/17/89	2.34 \pm 0.15	
115L	0+45	E-12	03/17/89	2.15 \pm 0.14	
125L	0+45	E-13	03/16/89	1.80 \pm 0.13	
135L	0+45	E-14	03/16/89	2.95 \pm 0.17	
145L	0+45	E-15	03/14/89	2.46 \pm 0.12	
155L	0+45	KE-1	05/20/89	3.05 \pm 0.16	
165L	0+45	KE-2	05/25/89	2.71 \pm 0.18	
175L	0+45	KE-3	05/20/89	2.39 \pm 0.14	
185L	0+45	KE-4	05/22/89	2.04 \pm 0.13	
15R	0+55	AF-2	05/25/89	1.52 \pm 0.12	
5R	0+55	AF-1	05/20/89	2.10 \pm 0.13	
5L	0+55	F-1	04/21/89	1.89 \pm 0.13	
15L	0+55	F-2	04/28/89	1.45 \pm 0.18	
25L	0+55	F-3	05/04/89	2.07 \pm 0.16	
35L	0+55	F-4	04/18/89	1.36 \pm 0.16	
45L	0+55	F-5	04/18/89	2.40 \pm 0.20	
55L	0+55	F-6	04/19/89	1.77 \pm 0.18	
65L	0+55	F-7	05/04/89	0.82 \pm 0.08	
75L	0+55	F-8	04/28/89	3.08 \pm 0.20	

TABLE E.1 (Cont'd)

Coordinates X Y		Grid ID	Sample Date	Ra-226 (609 keV) pCi/g $\pm \sigma$	
				--- Field ---	--- ACL ---
85L	0+55	F-9	04/18/89	1.41 \pm 0.17	
95L	0+55	F-10	04/28/89	2.17 \pm 0.16	
105L	0+55	F-11	04/11/89	2.31 \pm 0.14	
115L	0+55	F-12	03/17/89	2.15 \pm 0.14	
125L	0+55	F-13	03/16/89	2.11 \pm 0.14	
135L	0+55	F-14	03/16/89	1.58 \pm 0.11	
145L	0+55	F-15	03/14/89	1.90 \pm 0.11	
155L	0+55	KF-1	05/25/89	1.82 \pm 0.13	
165L	0+55	KF-2	05/24/89	2.70 \pm 0.15	
175L	0+55	KF-3	05/24/89	4.70 \pm 0.20	5.25 \pm 0.10
185L	0+55	KF-4	05/24/89	2.21 \pm 0.10	
15R	0+65	AG-2	05/25/89	3.37 \pm 0.17	
5R	0+65	AG-1	05/20/89	2.45 \pm 0.13	
5L	0+65	G-1	04/21/89	2.92 \pm 0.15	
15L	0+65	G-2	04/22/89	5.30 \pm 0.20	3.03 \pm 0.02
25L	0+65	G-3	05/04/89	1.52 \pm 0.12	
35L	0+65	G-4	04/18/89	1.22 \pm 0.17	
45L	0+65	G-5	04/18/89	1.47 \pm 0.17	
55L	0+65	G-6	04/19/89	1.58 \pm 0.18	
65L	0+65	G-7	04/14/89	2.06 \pm 0.14	
75L	0+65	G-8	04/12/89	1.86 \pm 0.14	2.46 \pm 0.03
75L	0+65	G-8	04/17/89	2.28 \pm 0.15	
85L	0+65	G-9	04/12/89	1.10 \pm 0.11	
95L	0+65	G-10	04/11/89	1.15 \pm 0.11	
105L	0+65	G-11	04/11/89	0.86 \pm 0.10	
115L	0+65	G-12	05/04/89	0.87 \pm 0.09	
125L	0+65	G-13	03/16/89	1.58 \pm 0.12	
135L	0+65	G-14	03/16/89	2.55 \pm 0.15	3.79 \pm 0.04
135L	0+65	G-14	05/04/89	2.69 \pm 0.19	
145L	0+65	G-15	03/14/89	2.36 \pm 0.12	3.60 \pm 0.05
145L	0+65	G-15	05/04/89	2.53 \pm 0.19	
155L	0+65	KG-1	05/22/89	4.21 \pm 0.20	4.84 \pm 0.11
165L	0+65	KG-2	05/24/89	2.70 \pm 0.16	
5R	0+75	AH-1	05/20/89	3.58 \pm 0.17	3.76 \pm 0.12
5L	0+75	H-1	04/21/89	1.80 \pm 0.12	
15L	0+75	H-2	05/01/89	0.60 \pm 0.13	
25L	0+75	H-3	05/04/89	2.16 \pm 0.13	
35L	0+75	H-4	04/18/89	1.17 \pm 0.17	
45L	0+75	H-5	04/18/89	1.32 \pm 0.17	
55L	0+75	H-6	04/19/89	1.56 \pm 0.16	
65L	0+75	H-7	04/14/89	2.03 \pm 0.14	
75L	0+75	H-8	04/17/89	2.46 \pm 0.16	3.30 \pm 0.03
85L	0+75	H-9	04/12/89	0.88 \pm 0.11	

TABLE E.1 (Cont'd)

Coordinates		Grid ID	Sample Date	Ra-226 (609 keV) pCi/g $\pm \sigma$	
X	Y			--- Field ---	--- ACL ---
95L	0+75	H-10	04/11/89	1.59 \pm 0.12	
105L	0+75	H-11	04/11/89	0.95 \pm 0.11	
115L	0+75	H-12	05/01/89	0.66 \pm 0.11	
125L	0+75	H-13	04/28/89	1.09 \pm 0.13	
135L	0+75	H-14	04/28/89	2.84 \pm 0.18	2.85 \pm 0.05
145L	0+75	H-15	03/14/89	2.64 \pm 0.13	
155L	0+75	KH-1	05/22/89	2.39 \pm 0.16	
165L	0+75	KH-2	05/24/89	1.66 \pm 0.12	
5R	0+85	AJ-1	05/25/89	2.42 \pm 0.16	
5L	0+85	J-1	05/19/89	2.20 \pm 0.14	
15L	0+85	J-2	05/04/89	2.29 \pm 0.12	
25L	0+85	J-3	05/04/89	1.79 \pm 0.12	
35L	0+85	J-4	05/04/89	1.36 \pm 0.12	
45L	0+85	J-5	04/18/89	1.62 \pm 0.17	
55L	0+85	J-6	04/19/89	1.50 \pm 0.17	
65L	0+85	J-7	04/14/89	1.53 \pm 0.12	
75L	0+85	J-8	04/17/89	1.79 \pm 0.13	
85L	0+85	J-9	04/12/89	1.12 \pm 0.10	
95L	0+85	J-10	04/11/89	1.13 \pm 0.10	
105L	0+85	J-11	04/11/89	0.90 \pm 0.10	
115L	0+85	J-12	05/01/89	0.72 \pm 0.11	
125L	0+85	J-13	04/28/89	1.10 \pm 0.16	
135L	0+85	J-14	04/28/89	1.52 \pm 0.14	
145L	0+85	J-15	04/28/89	3.55 \pm 0.19	
155L	0+85	KJ-1	05/22/89	2.09 \pm 0.11	
165L	0+85	KJ-2	05/24/89	1.91 \pm 0.14	
5R	0+95	AK-1	05/25/89	3.96 \pm 0.18	5.92 \pm 0.16
5L	0+95	K-1	05/04/89	4.07 \pm 0.17	5.23 \pm 0.09
15L	0+95	K-2	05/04/89	3.46 \pm 0.15	
25L	0+95	K-3	05/04/89	3.02 \pm 0.14	
35L	0+95	K-4	05/04/89	1.50 \pm 0.12	
45L	0+95	K-5	04/18/89	1.62 \pm 0.17	
55L	0+95	K-6	04/19/89	1.75 \pm 0.18	
65L	0+95	K-7	04/14/89	1.16 \pm 0.12	
75L	0+95	K-8	05/04/89	2.25 \pm 0.12	
85L	0+95	K-9	04/12/89	1.77 \pm 0.14	2.34 \pm 0.04
95L	0+95	K-10	04/11/89	0.87 \pm 0.10	
105L	0+95	K-11	04/11/89	0.84 \pm 0.10	
115L	0+95	K-12	05/04/89	0.79 \pm 0.11	
125L	0+95	K-13	04/28/89	0.93 \pm 0.14	
135L	0+95	K-14	04/28/89	1.97 \pm 0.16	
145L	0+95	K-15	04/28/89	2.72 \pm 0.15	

TABLE E.1 (Cont'd)

Coordinates X Y		Grid ID	Sample Date	Ra-226 (609 keV) pCi/g $\pm \sigma$	
				--- Field ---	--- ACL ---
155L	0+95	KK-1	05/22/89	3.27 \pm 0.17	
165L	0+95	KK-2	05/24/89	2.34 \pm 0.15	
5R	1+05	AL-1	05/25/89	5.31 \pm 0.21	5.14 \pm 0.16
5L	1+05	L-1	05/04/89	3.23 \pm 0.18	
15L	1+05	L-2	05/04/89	5.26 \pm 0.18	7.12 \pm 0.04
25L	1+05	L-3	05/04/89	4.55 \pm 0.17	
35L	1+05	L-4	05/04/89	1.81 \pm 0.12	
45L	1+05	L-5	04/28/89	2.51 \pm 0.15	
55L	1+05	L-6	04/28/89	1.16 \pm 0.15	
65L	1+05	L-7	05/04/89	1.13 \pm 0.08	
75L	1+05	L-8	05/01/89	0.91 \pm 0.12	
85L	1+05	L-9	05/04/89	1.58 \pm 0.15	
95L	1+05	L-10	05/04/89	1.91 \pm 0.11	
105L	1+05	L-11	05/04/89	1.93 \pm 0.10	
115L	1+05	L-12	05/01/89	1.24 \pm 0.11	
125L	1+05	L-13	04/28/89	1.32 \pm 0.14	
135L	1+05	L-14	04/28/89	2.84 \pm 0.15	
145L	1+05	L-15	04/28/89	2.24 \pm 0.15	
155L	1+05	KL-1	05/22/89	3.70 \pm 0.18	3.84 \pm 0.06
165L	1+05	KL-2	05/25/89	4.93 \pm 0.20	7.06 \pm 0.13
5R	1+15	AM-1	05/25/89	4.77 \pm 0.20	5.83 \pm 0.15
5L	1+15	M-1	05/04/89	3.15 \pm 0.20	
15L	1+15	M-2	04/28/89	4.09 \pm 0.18	3.72 \pm 0.03
15L	1+15	M-2	05/04/89	3.07 \pm 0.21	
25L	1+15	M-3	05/04/89	1.37 \pm 0.10	
35L	1+15	M-4	05/04/89	4.03 \pm 0.16	5.49 \pm 0.05
45L	1+15	M-5	04/28/89	2.81 \pm 0.16	
55L	1+15	M-6	04/28/89	2.16 \pm 0.17	
65L	1+15	M-7	04/28/89	4.16 \pm 0.21	
75L	1+15	M-8	05/04/89	1.18 \pm 0.17	
85L	1+15	M-9	05/04/89	0.82 \pm 0.08	
95L	1+15	M-10	05/01/89	0.98 \pm 0.13	
105L	1+15	M-11	05/01/89	1.37 \pm 0.12	
115L	1+15	M-12	05/02/89	1.61 \pm 0.12	
125L	1+15	M-13	04/28/89	1.59 \pm 0.15	
135L	1+15	M-14	04/28/89	3.37 \pm 0.18	
145L	1+15	M-15	04/28/89	3.20 \pm 0.16	
155L	1+15	KM-1	05/22/89	2.10 \pm 0.13	
165L	1+15	KM-2	05/24/89	2.23 \pm 0.14	

TABLE E.1 (Cont'd)

Coordinates X Y		Grid ID	Sample Date	Ra-226 (609 keV) pCi/g $\pm \sigma$	
				--- Field ---	--- ACL ---
5R	1+25	AN-1	05/25/89	2.09 \pm 0.13	
5L	1+25	N-1	05/04/89	3.51 \pm 0.18	
15L	1+25	N-2	05/04/89	1.03 \pm 0.09	
25L	1+25	N-3	05/04/89	4.00 \pm 0.19	
35L	1+25	N-4	05/04/89	1.13 \pm 0.09	
45L	1+25	N-5	04/28/89	1.95 \pm 0.14	
55L	1+25	N-6	04/28/89	2.33 \pm 0.18	3.20 \pm 0.03
65L	1+25	N-7	04/28/89	0.80 \pm 0.16	
75L	1+25	N-8	05/01/89	0.96 \pm 0.12	
85L	1+25	N-9	05/04/89	0.96 \pm 0.14	
95L	1+25	N-10	05/01/89	1.14 \pm 0.14	
105L	1+25	N-11	05/01/89	1.43 \pm 0.13	
115L	1+25	N-12	05/04/89	1.99 \pm 0.18	
125L	1+25	N-13	04/28/89	1.39 \pm 0.15	1.95 \pm 0.02
135L	1+25	N-14	04/28/89	2.25 \pm 0.16	
145L	1+25	N-15	04/28/89	2.78 \pm 0.15	
155L	1+25	KN-1	05/22/89	2.87 \pm 0.15	
165L	1+25	KN-2	05/24/89	2.68 \pm 0.16	
5R	1+35	AP-1	05/25/89	2.32 \pm 0.15	
5L	1+35	P-1	05/04/89	2.61 \pm 0.15	
15L	1+35	P-2	05/04/89	4.54 \pm 0.17	
25L	1+35	P-3	05/04/89	3.23 \pm 0.14	
35L	1+35	P-4	05/04/89	1.06 \pm 0.09	
45L	1+35	P-5	04/28/89	0.94 \pm 0.13	
55L	1+35	P-6	04/28/89	1.29 \pm 0.15	
65L	1+35	P-7	04/28/89	1.21 \pm 0.16	
75L	1+35	P-8	05/01/89	3.07 \pm 0.16	
85L	1+35	P-9	05/01/89	1.14 \pm 0.13	
95L	1+35	P-10	05/01/89	1.53 \pm 0.13	
105L	1+35	P-11	05/04/89	1.52 \pm 0.10	
115L	1+35	P-12	05/04/89	2.56 \pm 0.13	
125L	1+35	P-13	04/28/89	1.35 \pm 0.15	
135L	1+35	P-14	04/28/89	2.33 \pm 0.16	
145L	1+35	P-15	04/28/89	3.42 \pm 0.19	
155L	1+35	KP-1	05/22/89	2.78 \pm 0.15	
165L	1+35	KP-2	05/24/89	3.16 \pm 0.17	
5R	1+45	AR-1	05/25/89	1.58 \pm 0.12	3.30 \pm 0.08
5L	1+45	R-1	05/04/89	1.53 \pm 0.11	
15L	1+45	R-2	05/04/89	4.29 \pm 0.19	6.37 \pm 0.05
25L	1+45	R-3	05/04/89	2.29 \pm 0.12	
35L	1+45	R-4	05/04/89	1.50 \pm 0.11	
45L	1+45	R-5	04/28/89	1.83 \pm 0.16	
55L	1+45	R-6	04/28/89	1.82 \pm 0.16	

TABLE E.1 (Cont'd)

Coordinates		Grid ID	Sample Date	Ra-226 (609 keV) pCi/g $\pm \sigma$	
X	Y			--- Field ---	--- ACL ---
65L	1+45	R-7	04/28/89	0.86 \pm 0.15	
75L	1+45	R-8	05/01/89	1.50 \pm 0.14	
85L	1+45	R-9	05/01/89	1.40 \pm 0.13	
95L	1+45	R-10	05/01/89	2.42 \pm 0.15	
105L	1+45	R-11	05/04/89	1.64 \pm 0.16	
115L	1+45	R-12	05/04/89	2.15 \pm 0.12	
125L	1+45	R-13	04/28/89	3.24 \pm 0.15	
135L	1+45	R-14	04/28/89	2.69 \pm 0.16	
145L	1+45	R-15	04/28/89	2.70 \pm 0.17	2.71 \pm 0.04
155L	1+45	KR-1	05/22/89	2.78 \pm 0.16	
165L	1+45	KR-2	05/24/89	2.73 \pm 0.17	
185L	1+45	R-19	05/01/89	2.18 \pm 0.13	
65R	1+55	AS-7	04/27/89	3.64 \pm 0.22	
15R	1+55	AS-2	04/27/89	2.69 \pm 0.18	
5R	1+55	AS-1	04/27/89	2.42 \pm 0.20	
65L	1+55	S-7	05/08/89	1.59 \pm 0.12	
75L	1+55	S-8	05/08/89	2.13 \pm 0.13	
85L	1+55	S-9	05/08/89	2.32 \pm 0.14	
95L	1+55	S-10	05/08/89	1.89 \pm 0.12	
105L	1+55	S-11	05/08/89	3.35 \pm 0.15	
115L	1+55	S-12	05/08/89	2.56 \pm 0.13	
165L	1+55	KS-2	04/27/89	3.52 \pm 0.16	4.15 \pm 0.05
175L	1+55	KS-2	04/27/89	3.31 \pm 0.17	
185L	1+55	KS-4	04/27/89	4.18 \pm 0.18	
65L	1+65	T-7	05/08/89	2.76 \pm 0.15	3.34 \pm 0.07
85L	1+65	T-9	05/08/89	0.86 \pm 0.10	
Stratford Sewer Line					
55L	1+75	U-6	04/18/89	2.84 \pm 0.17	3.68 \pm 0.03
65L	1+75	U-7	04/19/89	2.31 \pm 0.16	
75L	1+75	U-8	04/19/89	2.17 \pm 0.16	3.06 \pm 0.03
85L	1+75	U-9	04/21/89	3.45 \pm 0.18	
95L	1+75	U-10	04/21/89	3.87 \pm 0.18	
105L	1+75	U-11	04/21/89	2.29 \pm 0.17	
115L	1+75	U-12	04/21/89	4.43 \pm 0.20	
125L	1+75	U-13	04/21/89	2.76 \pm 0.17	
135L	1+75	U-14	04/22/89	3.90 \pm 0.20	5.36 \pm 0.06
145L	1+75	U-15	04/22/89	2.17 \pm 0.11	
155L	1+75	U-16	04/22/89	1.14 \pm 0.12	
165L	1+75	U-17	04/22/89	2.13 \pm 0.15	
175L	1+75	U-18	04/22/89	1.66 \pm 0.11	

TABLE E.1 (Cont'd)

Coordinates X Y		Grid ID	Sample Date	Ra-226 (609 keV) pCi/g $\pm \sigma$	
				--- Field ---	--- ACL ---
185L	1+85	U-19	04/22/89	1.24 \pm 0.10	
195L	1+85	V-20	04/24/89	1.11 \pm 0.11	
205L	1+85	V-21	04/24/89	1.45 \pm 0.11	
215L	1+85	V-22	04/24/89	1.34 \pm 0.11	
225L	1+85	V-23	04/24/89	1.97 \pm 0.12	
235L	1+85	V-24	04/24/89	1.62 \pm 0.12	
245L	1+85	V-25	04/24/89	1.66 \pm 0.13	
255L	1+85	V-26	04/24/89	1.70 \pm 0.20	2.37 \pm 0.02
265L	1+85	V-27	04/24/89	1.10 \pm 0.10	
275L	1+85	V-28	04/24/89	1.10 \pm 0.11	
285L	1+85	V-29	04/24/89	1.48 \pm 0.11	
South Parkway					
45L	1+85	V-5	04/26/89	2.84 \pm 0.24	
55L	1+85	V-6	04/26/89	1.40 \pm 0.21	
65L	1+85	V-7	04/26/89	1.44 \pm 0.20	
75L	1+85	V-8	04/26/89	3.13 \pm 0.23	4.76 \pm 0.03
85L	1+85	V-9	04/26/89	3.30 \pm 0.23	
105L	1+85	V-11	04/26/89	3.40 \pm 0.24	
115L	1+85	V-12	04/26/89	1.22 \pm 0.10	
125L	1+85	V-13	04/26/89	2.55 \pm 0.13	
135L	1+85	V-14	04/26/89	2.05 \pm 0.13	
Ave				2.11	4.20
Std dev				0.95	1.33
Max				5.49	7.17
Min				0.53	1.95
No of Samples				393	47

oUncertainty in counting statistics.

ARGAPPF

APPENDIX F

APPENDIX F

FEDERAL REGULATIONS PERTINENT TO THE SITE CLEAN-UP ACTIVITIES

40 CFR Part 192 HEALTH AND ENVIRONMENTAL PROTECTION STANDARDS FOR URANIUM MILL TAILINGS

(Excerpts have been retyped for purposes of this report)

In 1983, regulations were published by the U.S. Environmental Protection Agency as 40 CFR Part 192, *Health and Environmental Protection Standards for Uranium Mill Tailings*, for control and cleanup of residual radioactive material at inactive uranium processing sites. The standard for ²²⁶Ra is excerpted below from Subpart B -- *Standards for Cleanup of Open Lands and Buildings Contaminated with Residual Radioactive Materials from Inactive Uranium Processing Sites*.

192.10 Applicability

This subpart applies to land and buildings which are part of any processing site designated by the Secretary of Energy under Pub. L. 95-604, Section 102. Section 101 of Pub. L. 95-604, states that "processing site" means --

(a) any site, including the mill, containing residual radioactive materials at which all or substantially all of the uranium was produced for sale to any Federal agency prior to January 1, 1971, under a contract with any Federal agency, except in the case of a site at or near Slick Rock, Colorado, unless --

(1) such site was owned or controlled as of January 1, 1978, or is thereafter owned or controlled, by a Federal agency, or

(2) a license [issued by the (Nuclear Regulatory) Commission or its predecessor agency under the Atomic Energy Act of 1954 or by a State as permitted under Section 274 of such Act] for the production at such site of any uranium or thorium product derived from ores is in effect on January 1, 1978, or is issued or renewed after such date; and

(b) Any other real property or improvement thereon which --

(1) is in the vicinity of such site, and

(2) is determined by the Secretary, in consultation with the Commission, to be contaminated with residual radioactive materials derived from such site.

192.11 Definitions

(a) Unless otherwise indicated in this subpart, all terms shall have the same meaning as defined in Title I of the Act or in Subpart A.

(b) Land means any surface or subsurface land that is not part of a disposal site and is not covered by an occupiable building.

(c) Working Level (WL) means combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of alpha particles with a total energy of 130 billion electron volts.

(d) Soil means all unconsolidated materials normally found on or near the surface of the earth including, but not limited to silts, clays, sands, gravel, and small rocks.

192.12 Standards

Remedial actions shall be conducted so as to provide reasonable assurance that, as a result of residual radioactive materials from any designated processing site:

(a) the concentration of radium-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than --

(1) 5 pCi/g, averaged over the first 15 cm of soil below the surface, and

(2) 15 pCi/g, averaged 15 cm thick layers of soil more than 15 cm below the surface.

(b) in any occupied or habitable building --

(1) the objective of remedial action shall be, and reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL. In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL, and

(2) the level of gamma radiation shall not exceed the background level by more than 20 microroentgens per hour.

10 CFR Part 20
STANDARDS FOR PROTECTION AGAINST RADIATION

(Excerpts have been retyped for purposes of this report)

Section 303 - Disposal by release into sanitary sewerage systems

No licensee shall discharge licensed material into a sanitary sewerage system unless:

- (a) It is readily soluble or dispersible in water; and
- (b) The quantity of any licensed or other radioactive material released into the system by the licensee in any one day does not exceed the larger of paragraphs (b)(1) or (2) of this section.
 - (1) The quantity which, if diluted by the average daily quantity of sewage released into the sewer by the licensee, will result in an average concentration equal to the limits specified in Appendix B, Table I, Column 2 of this part; or
 - (2) Ten times the quantity of such material specified in Appendix C of this part; and
- (c) The quantity of any licensed or other radioactive material released in any one month, if diluted by the average monthly quantity of water released by the licensee, will not result in an average concentration exceeding the limits specified in Appendix B, Table I, Column 2 of this part; and
- (d) The gross quantity of licensed and other radioactive material, excluding hydrogen-3 and carbon-14, released into the sewerage system by the licensee does not exceed one curie per year for carbon-14. Excreta from individuals undergoing medical diagnosis or therapy with radioactive material shall be exempt from any limitations contained in this section.

**Concentrations in Air and Water Above Natural Background (Appendix B,
10 CFR Part 20)**

Isotope			Table I		Table II	
Element (atomic number)			Col. 1 - Air ($\mu\text{Ci/mL}$)	Col. 2 - Water ($\mu\text{Ci/mL}$)	Col. 1 - Air ($\mu\text{Ci/mL}$)	Col. 2 - Water ($\mu\text{Ci/mL}$)
Radium (88)	Ra 226	S	3×10^{-11}	4×10^{-7}	3×10^{-12}	3×10^{-8}
		I	5×10^{-11}	9×10^{-4}	2×10^{-12}	3×10^{-5}

Note: In any case where there is a mixture in air or water or more than one radionuclide, the limiting values for purposes of this Appendix should be determined as follows:

1. If the identity and concentration of each radionuclide in the mixture are known, the limiting values should be derived as follows: Determine, for each radionuclide in the mixture, the ratio between the quantity present in the mixture and the limit otherwise established in Appendix B for the specific radionuclide when not in a mixture. The sum of such ratios for all the radionuclides in the mixture may not exceed "1" (i.e., "unity")

Example: If radionuclides A, B, and C are present in concentrations C_a , C_b , and C_c , and if the applicable MPC's are MPC_a and MPC_b , and MPC_c respectively, then the concentrations shall be limited so that the following relationship exists.

$$(C_a/\text{MPC}_a) + (C_b/\text{MPC}_b) + C_c/\text{MPC}_c \leq 1$$

2. If either the identity or the concentration of any radionuclide in the mixture is not known, the limiting values for purposes of Appendix B (10 CFR Part 20) shall be:

- For purposes of Table I, Col. 1 - 6×10^{-13}
- For purposes of Table I, Col. 2 - 4×10^{-7}
- For purposes of Table II, Col. 1 - 2×10^{-14}
- For purposes of Table II, Col. 2 - 3×10^{-8}

(Appendix C, 10 CFR Part 20)

Material	Microcuries
Radium-226	0.01
Thorium (natural) ¹	100
Uranium (natural) ²	100
Any alpha emitting radionuclide and listed above or mixtures of alpha emitters of unknown composition	0.01

¹Based on alpha disintegration rate of Th-232, Th-230, and their daughter products.

²Based on alpha disintegration rate of U-238, U-234, and U-235.

Note: For purposes of §20.303, where there is involved a combination of isotopes in known amounts, the limit for the combination should be derived as follows: Determine, for each isotope in the combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific isotope when not in combination. The sum of such ratios for all the isotopes in the combination may not exceed "1" (i.e., "unity").

**U.S. DEPARTMENT OF ENERGY GUIDELINES
FOR RESIDUAL RADIOACTIVE MATERIAL AT
FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM
AND
REMOTE SURPLUS FACILITIES MANAGEMENT PROGRAM SITES**

(Excerpts have been re-typed for purposes of this report)

1.0 INTRODUCTION

This document presents U.S. Department of Energy (DOE) radiological protection guidelines for cleanup of residual radioactive material and management of the resulting wastes and residues. It is applicable to sites identified by the Formerly Utilized Sites Remedial Action Program (FUSRAP) and remote sites identified by the Surplus Facilities Management Program (SFMP).*

"Residual radioactive material" is used in these guidelines to describe radioactive material derived from operations or sites over which DOE has authority. Guidelines or guidance to limit the levels of radioactive material and to protect the public and the environment are provided for (1) residual concentrations of radionuclides in soil,[†] (2) concentrations of airborne radon decay products, (3) external gamma radiation levels, (4) surface contamination levels, and (5) radionuclide concentrations in air or water resulting from or associated with any of the above.

A "guideline" for residual radioactive material is a level of radioactivity or radioactive material that is acceptable if use of the site is to be unrestricted. Guidelines for residual radioactive material presented herein are of two kinds: (1) generic, site-independent guidelines taken from existing radiation protection standards and (2) site-specific guidelines derived from basic dose limits using site-specific models and data. Generic guideline values are presented in this document. Procedures and data for deriving site-specific guideline values are given in the supplement. The basis for the guidelines is generally a presumed worst-case plausible-use scenario for the site.

2.0 GUIDELINES FOR RESIDUAL RADIOACTIVE MATERIAL

Residual Radionuclides in Soil

Residual concentrations of radionuclides in soil shall be specified as above-background concentrations averaged over an area of 100 m². Generic guidelines for thorium and radium are specified below. Guidelines for residual concentrations of other radionuclides shall be derived from the basic dose limits by means of an environmental pathway analysis using site-specific data where available. Procedures for these derivations are given in the supplement.

*A remote SFMP site is one that is excess to DOE programmatic needs and is located outside a major operating DOE research and development or production area.

[†]"Soil" is defined herein as unconsolidated earth material, including rubble and debris that may be present in earth material.

If the average concentration in any surface or below-surface area less than or equal to 25 m² exceeds the authorized limit or guideline by a factor of $(100/A)^{1/2}$, where A is the area of the elevated region in square meters, limits for "hot spots" shall also be applicable. Procedures for calculating these hot spot limits, which depend on the extent of the elevated local concentrations, are given in the supplement. In addition, every reasonable effort shall be made to remove any source of radionuclide that exceeds 30 times the appropriate limit for soil, irrespective of the average concentration in the soil.

Two types of guidelines are provided, generic and derived. The generic guidelines for residual concentrations of Ra-226, Ra-228, Th-230, and Th-232 are:

-5 pCi/g, averaged over the first 15 cm of soil below the surface

-15 pCi/g, averaged over 15-cm-thick layers of soil more than 15 cm below the surface

These guidelines take into account ingrowth of Ra-226 from Th-230 and of Ra-228 from Th-232, and assume secular equilibrium. If either Th-230 and Ra-226 or Th-232 and Ra-228 are both present, not in secular equilibrium, the appropriate guideline is applied as a limit to the radionuclide with the higher concentration. If other mixtures of radionuclides occur, the concentrations of individual radionuclides shall be reduced so that (1) the dose for the mixtures will not exceed that basic dose limit or (2) the sum of the ratios of the soil concentration of each radionuclide to the allowable limit for that radionuclide will not exceed 1 ("unity"). Explicit formulas for calculating residual concentration guidelines for mixtures are given in the supplement.

APPENDIX G

APPENDIX G

EVALUATION OF RADIATION EXPOSURES TO MEMBERS OF THE PUBLIC

1.0 INTRODUCTION

1.1 Types of Radiation

Radiation is the emission or transmission of energy in the form of waves or particles. Examples are acoustic waves (i.e., sound), electromagnetic waves (such as radio, light, x- and gamma-rays), and particulate radiations (such as alpha particles, beta particles, neutrons, protons, and other elementary particles).

The class of radiation of importance in this report is known as ionizing radiation. Ionizing radiations are those, either electromagnetic or particulate, with sufficient energy to ionize matter, i.e., to remove or displace electrons from atoms and molecules. The most common types of ionizing radiation are x- and gamma-rays, alpha particles, beta particles, and neutrons.

X- and gamma-rays are electromagnetic radiation and are identical except that x-rays originate in the electronic structure of an atom and gamma-rays originate in the nucleus of an atom. X- and gamma-rays are highly penetrating and can pass through relatively thick materials before interacting. Upon interaction, some or all of the energy is transferred to electrons which, in turn, produce additional ionizations while coming to rest.

Alpha particles are positively charged particles composed of two neutrons and two protons, identical to the nucleus of a helium atom. Due to its comparatively large mass and double charge, an alpha particle interacts readily with matter and penetrates only a very short distance before coming to rest, causing intense ionization along its path.

Beta particles are negatively charged free electrons moving at high speeds. Due to their comparatively small mass and single charge, a beta particle's penetration through matter is intermediate between that of the alpha particle and the gamma-ray, causing fewer ionizations per unit path length than an alpha particle.

1.2 Sources of Radiation

Ionizing radiations arise from terrestrial radioactive materials (both naturally occurring and manmade), extra-terrestrial (cosmic) sources, and radiation-producing machines. The sources of ionizing radiation important in this report involve the technology-enhanced natural radioactive material, ^{226}Ra .

Most atoms of the elements in our environment remain structurally stable. With time, an atom of potassium, for instance, may change its association with other atoms in chemical reactions and become part of other compounds, but it will always remain a potassium atom. Radioactive atoms, on the other hand, are not stable and will spontaneously emit radiation in order to achieve a more stable state. Because of this spontaneous transformation, the ratio of protons and neutrons in the nucleus of an atom is altered toward a more stable condition. Radiation may be emitted from the nucleus as alpha particles, beta particles, neutrons, or gamma-rays, depending uniquely upon each particular radionuclide. Radionuclides decay at characteristic rates dependent upon the degree of stability and characterized by a period of time called the half-life. In one half-life, the number of radioactive atoms and, therefore, the amount of radiation emitted, decrease by one half.

The exposure of man to terrestrial radiation is due to naturally occurring radionuclides and also to "manmade" and technologically enhanced radioactive materials. Several dozen radionuclides occur naturally, some having half-lives of at least the same order of magnitude as the estimated age of the earth. The majority of these naturally occurring radionuclides are isotopes of the heavy elements and belong to three distinct radioactive series headed by uranium-238, uranium-235, and thorium-232. Each of these decays to stable isotopes of lead through a sequence of radionuclides of widely varying half-lives. Other naturally occurring radionuclides, which decay directly to a stable nuclide, are potassium-40 and rubidium-87. It should be noted that even though the isotopic abundance of potassium-40 is less than 0.012%, potassium is so widespread that potassium-40 contributes about one-third of the radiation dose received by man from natural background radiation. A major portion of the exposure (dose) of man from external terrestrial radiation is due to the radionuclides in the soil, primarily potassium-40 and the radioactive decay-chain products of thorium-232 and uranium-238. The naturally occurring radionuclides deposited internally in man through intake by inhalation/ingestion of air, food, and drinking water containing the natural radioactive elements also contribute significantly to his total dose. Many other radionuclides are referred to as "man made" in the sense that they can be produced in large quantities by such means as operating nuclear reactors or accelerators, or conducting nuclear weapons tests.

The term "cosmic radiation" refers both to the primary energetic particles of extra-terrestrial origin that are incident on the earth's atmosphere and to the secondary particles that are generated by the interaction of these primary particles with the atmosphere and subsequently reach ground level. Primary cosmic radiation consists of "galactic" particles externally incident on the solar system, and "solar" particles emitted by the sun. This radiation is composed primarily of energetic protons and alpha particles. The first generation of secondary particles (secondary cosmic radiation), produced by nuclear interactions of the primary particles with the atmosphere, consists predominantly of neutrons, protons, and pions. Pion decay, in turn, results in the production of electrons, photons, and muons. At the lower elevations, the highly penetrating muons and their associated decay and collision electrons are the dominant components of the cosmic-ray flux density. These particles, together with photons from the gamma-emitting, naturally occurring radionuclides in the local environment, form the external penetrating component of the background environmental radiation field.

In addition to the direct cosmic radiation, cosmic sources include cosmic-ray produced radioactivity, i.e., cosmogenic radionuclides. The major production of cosmogenic radionuclides is through interaction of the cosmic rays with the atmospheric gases through a variety of spallation or neutron-capture reactions. The four cosmogenic radionuclides that contribute a comparatively small radiation dose to man are carbon-14, sodium-22, beryllium-7, and hydrogen-3 (tritium), all produced in the atmosphere.

2.0 BACKGROUND RADIATION DOSES

Background radiation doses are comprised of an external component of radiation impinging on man outside the body and an internal component due to radioactivity taken into the body principally by inhalation or ingestion.

Radiation dose may be expressed in units of rads or rems, depending upon whether the reference is to the energy deposited or to the biological effect of the energy deposited. A rad is the amount of radiation that deposits a certain amount of energy in each gram of material. It applies to all radiations and to all materials which absorb that radiation.

Since the amount of energy lost per unit pathlength depends upon the type of radiation as it travels through tissue, differences in damage to tissues have been observed. A rem is defined as the amount of energy absorbed (in rads) from a given type of radiation multiplied by the factor appropriate for the particular type of radiation in order to approximate the biological damage that it causes relative to a rad of x or gamma radiation. The concept behind the unit "rem" permits evaluation of potential effects from radiation exposure without regard to the type of radiation or its source. One rem received from cosmic radiation results in the same biological effects as one rem from medical x-rays or one rem from the radiations emitted by naturally occurring or manmade radioactive materials.

The external penetrating radiation dose to man derives from both terrestrial radioactivity and cosmic radiation. The terrestrial component is due primarily to the gamma dose from potassium-40 and the radioactive decay products of thorium-232 and uranium-238 in soil. The population-weighted external dose to an individual's whole body from terrestrial sources in the United States has been estimated as 16 mrem per year for the Atlantic and Gulf Coastal Plain, 63 mrem per year for the Rocky Mountain area including Denver, and 32 mrem per year for the noncoastal plain (NCRP94). The cosmic radiation dose, due to the charged particles and neutrons from secondary cosmic rays, is typically about 30% to 50% of the total from all external environmental radiation. The cosmic-ray dose to the U.S. population is estimated to be 26 mrem per year (NCRP94).

The internal radiation doses derive from terrestrial and cosmogenic radionuclides deposited within the body through uptake by inhalation/ingestion of air, food, and drinking water. Once deposited in the body, many radioactive materials can be incorporated into tissues because the chemical properties of the radioisotopes are identical or similar to the properties of stable isotopes in the tissues. Potassium-40, for instance, is incorporated into tissues in the same manner as stable potassium atoms

because the chemical properties are identical; radioactive radium and strontium can be incorporated into tissues in the same manner as calcium because their chemical properties are similar. Once deposited in tissue, these radionuclides emit radiation that results in the internal dose to individual organs and/or the whole body as long as the radioactive material is in the body.

Approximately two-thirds of the total dose received by members of the general public from exposure to natural sources of radiation/radioactivity can be attributed to that dose received from the inhalation of the short-lived radon daughter products. Continuous exposure to short-lived radon daughter products at a level of 4 milli-working levels would result in an annual whole lung dose of 1600 mrem. Actual doses to the bronchial epithelium at this exposure level would be 2400 mrem (NCRP94). The whole lung dose of 1600 mrem can be expressed in terms of a "whole body" effective dose by applying a lung tissue weighting factor (W_t) of 0.12 derived by the International Commission on Radiological Protection (ICRP). Weighting factors were derived in an attempt to provide a common foundation whereby irradiation of single organs or tissues could be equated to an equivalent whole body exposure. A lung dose of 1600 mrem can be expressed on the basis of risk as comparable to a "whole body" exposure of 192 mrem (1600×0.12). This value has been rounded-up in Table G.1 to 200 mrem.

Internally deposited radionuclides via intake of food and water contribute relatively small doses in comparison to those from the radon daughter products. Uranium-238 decay chain products, thorium-232 decay chain products, and potassium-40 make-up virtually the entire internal dose from this exposure pathway. The total effective dose from these radionuclides is tabulated in Table G.1 under the source heading "in the body."

The total annual effective dose equivalent for a member of the general public from various sources of natural background radiation is estimated to be about 300 mrem (NCRP94). After accounting for the dose attributed to inhaled radioactivity (200 mrem), the remaining exposure pathways all appear to make an equal contribution to the balance of the total dose (e.g., 27 mrem from external cosmic irradiation; 28 mrem from external terrestrial irradiation; and 40 mrem from radionuclides deposited in the body via food/water intake).

Besides the natural background radiation, background radiation doses include contributions from manmade or technologically enhanced sources of radiation. By far, the most significant sources are x-ray and radiopharmaceutical medical examinations. These contribute a population-averaged dose estimated to be 70 mrem per year for the U.S. population as a whole. Fallout from nuclear weapons testing through 1970 has contributed 50-year dose commitments estimated as 80 mrem external, and 30, 20, and 45 mrem internal to the gonads, lung, and bone marrow, respectively. Contributions from the use of fossil fuels (natural gas and coal) and nuclear reactors; mining, milling and tailings piles; television sets, smoke detectors, and watch dials could be responsible for an additional 5 mrem per year, averaged over the U.S. population as a whole. In addition, the use of radiation or radioactivity for scientific, industrial, or medical purposes may cause workers in the industry and, to a lesser extent, members of the general public, to receive some radiation exposure above natural background.

TABLE G.1 Estimated Total Effective Dose Equivalent Rate for a Member of the Population in the United States and Canada^a from Various Sources of Natural Background Radiation

Source	Total effective dose equivalent rate (mrem/y)					Total
	Lung	Gonads	Bone Surfaces	Bone Marrow	Other Tissues ^b	
w_T	0.12	0.25	0.03	0.12	0.48	1.0
Cosmic	3	7	1	3	13	27
Cosmogenic	0.1	0.2	-	0.4	0.3	1
Terrestrial	3	7	1	3	14	28
Inhaled ^c	200	-	-	-	-	200
In the body	4	9	3	6	17	40
Rounded totals	210	23	5	12	44	300

^aThe effective dose equivalent rates for Canada are about 20% lower for the Terrestrial and Inhaled components.

^bThis is an approximation derived by assuming that the rest of the organs had the same dose equivalent rate as the gonads, adding 17 mrem/y.

^cDerived from calculations of ICRP Publication 32 (ICRP, 1981c).

w_T is a weighting factor derived to enable individual organ/tissue doses to be expressed in terms of an effective dose equivalent (uniform, whole body irradiation).

Source: Taken from NCRP Report No. 94 (1987).